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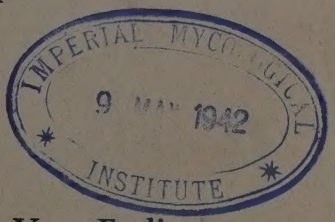
The Maine Agricultural Experiment Station

ORONO



Report of Progress for Year Ending June 30, 1941

UNIVERSITY OF MAINE
THE MAINE AGRICULTURAL EXPERIMENT STATION
ORONO, MAINE

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INTRODUCTION

Research is the frontier of any industry, and the progress of an industry over an extended period of time is directly proportionate to the accomplishments of research. The state agricultural experiment stations operate as an important part of this frontier of agriculture. The findings of these many organizations have been helpful in enabling the agricultural industry of this country to develop an efficiency unsurpassed anywhere in the world. Farming has become a highly technical enterprise in which success depends more and more upon the application of scientific principles involving the use of modern equipment and methods. Farm operators are more and more dependent upon the results of research and are looking with increased interest to their respective state stations for helpful information. The problems of each state are in some measure peculiar to that state, and the findings of one experiment station frequently are only partially applicable to the agriculture of any other section.

The solution of a problem is seldom accomplished in one calendar year and usually only after many years. When conclusive results are available the information is published through the medium of a station bulletin or as an article in some suitable periodical. An informed public, however, is an intelligent public and for this reason the stations in general resort to the publishing of quarterly or annual reports which set forth the progress made in their research programs during the period for which the reports are given. The Maine Station has just completed its fifty-sixth year of operations and the results obtained during the fiscal year ending June 30,1941, are set forth in the following pages.

APPLES

THE APPLE INDUSTRY IN MAINE. Charles H. Merchant. A survey of the apple industry in Maine was undertaken last summer and a mimeographed report has been made available to orchardists of the State. Information for this study was obtained

from 266 commercial apple growers located in fourteen counties of the State. The study deals with (1) the varieties of apples in commercial orchards, (2) the size of commercial orchards, (3) the orchard practices, (4) the hurricane injury in 1938, and (5) the storage of apples and the methods of selling apples.

The results of this study indicate that there are two major economic problems facing Maine orchardists. One is the proper storage of an increasing supply of McIntosh, Delicious, and Cortland apples. The other problem is the development of an efficient method of selling an increasing supply of fall variety apples.

APPLE BREEDING. Russell M. Bailey and Iva M. Burgess. A seedling apple orchard of about 1,500 trees has been established with material obtained in controlled crosses of various varieties. New seedling trees are added as rapidly as room for them can be made by discarding those seedlings, already in the orchard, which are found to produce inferior fruit. A promising new seedling obtained from the McIntosh x Red Delicious cross has been propagated and a limited number of trees will soon be available for trial. Several new varieties obtained from outside the State were set in the variety test orchard at Highmoor to check their possibilities for Maine orchards. Oswego Red Spy and Prairie Spy are two new late season varieties which appear worthy of limited trials in the orchards of this State.

HORMONE SPRAY ON APPLES TO PREVENT EXCESSIVE DROP AT HARVEST TIME. Russell M. Bailey. Maine orchardists frequently experience considerable loss from excessive dropping of McIntosh fruits during the harvest season. Little difficulty is experienced with the late maturing varieties. In the fall of 1940, a series of experiments was conducted at Highmoor Farm to determine the effectiveness of the newly developed hormone spray on the McIntosh variety under Maine conditions. "Niagara Stik," a commercial product having a sodium salt of naphthalene acetic acid as the active ingredient, was applied on several different dates. Each experiment consisted of three or five paired comparisons of a sprayed tree with an unsprayed check. The number of spray applications ranged from one to five, and the dates of application were September 14, 20, 23, and 27, and October 5. The coverage was excellent; the quantity applied at each spray was approximately one gallon per bushel of fruit. Frequent harvestings were made of dropped fruit. The dropped fruit of each tree was counted

and weighed in order to determine the percentage of the total crop dropped on different dates and also to study the relation of apple size to date of dropping. Pickings were made on September 26, October 1, 7, and 20, and the fruit was placed in cold storage in order to study the color and quality in relation to picking date. The results obtained are as follows:

1. Picking date in relation to marketable fruit. The stored fruit was packed on February 10, 1941, and the percentage of unmarketable fruit due to small size (less than two inches), rot, poor color, and other factors was determined. The percentage of culls for the picking dates of September 26, October 1, 7, and 20 was 4.0, 3.0, 1.4, and 16.0, respectively. The culls from the September 26 and October 1 pickings were principally due to small size and poor color. The few culls of the October 7 lot were chiefly due to rot. The loss from the October 20 picking was mostly due to overmaturity, which resulted in much rot and internal breakdown. These figures, together with the notes on color, firmness, and quality, indicate that at Highmoor Farm in 1940 around October 5 to 7 was the optimum time to harvest McIntosh fruit to secure the best quality. In most years the optimum period would probably be several days earlier.

2. Picking date in relation to size of fruit. The data taken on count and weight of dropped apples throughout the harvest period, September 19 to October 20, showed that the average size of dropped fruit increased 28.6 per cent during the period. This is shown in the following table:

Date	Average weight pounds per fruit	Number apples required to make a bushel
Sept. 19	.28	157
22	.28	157
24	.30	147
26	.30	147
28	.31	142
30	.31	142
Oct. 2	.31	142
4	.32	137
7	.34	129
11	.34	129
14	.36	122
16	.36	122
20	.36	122

3. Effect of the hormone spray on the retention of the fruit. A study of the plotted data from the six experiments indicates that spray applications before September 27 were not effective in reducing the drop. Applications made on September 27 and October 5 did reduce the drop as indicated by the following figure, which was made by grouping the experiments into those receiving sprays only before September 27 and those receiving September 27 and October 5 applications in addition.

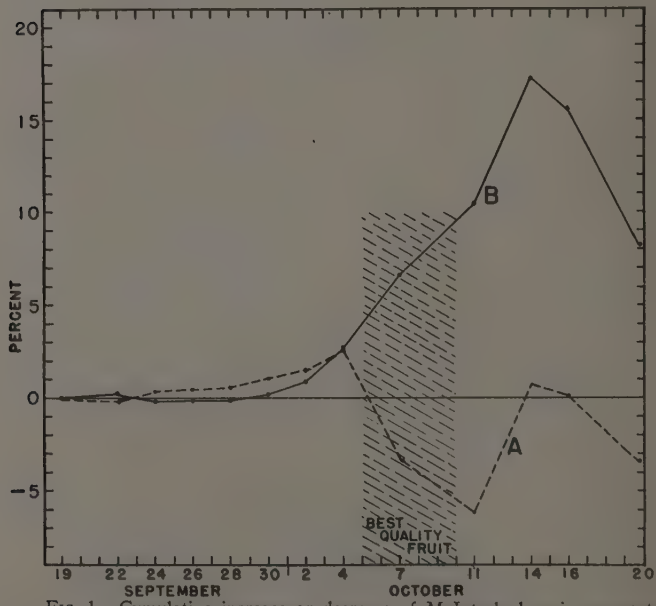

FIG. 1. Cumulative increase or decrease of McIntosh drop in per cent of total crop at different calendar dates with "hormone" sprayed trees compared to unsprayed checks.

Note: A—Results from trees sprayed before September 27
B—Results from trees having September 27 and October 5 applications in addition

The summarized data appear to justify the following conclusions:

1. Early spray applications of Niagara Stik applied on September 14, 20, and 23 did not significantly reduce the dropping of McIntosh apples in 1940.

2. Later applications made on September 27 and October 5 did significantly reduce the dropping of the fruit. Assuming October 7 in 1940 as the optimum picking date for McIntosh to secure the best quality, the saving due to the spray was 6.5 per cent of the crop or 12.9 pounds per tree. It is estimated that the saving due to the spray was just about sufficient to pay for the cost of the material in 1940.

3. The effective sprays, September 27 and October 5, afforded the maximum protection after the optimum picking date of October 7. On October 14 the cumulative gain in per cent of the crop retained on the tree due to the spray was over 17 per cent. This suggests that in some years when severe dropping is experienced that the spray may have practical value.

4. The plotted data indicate that the spray began to be effective in two or three days after application. The duration of the effectiveness appeared to be around 10 days. After the protective period, the sprayed fruit dropped at a faster rate than the unsprayed checks.

The Relationship of Apple Seedling Nursery Grade to Further Growth in a Changed Environment. Russell M. Bailey. It was previously reported (Me. Agr. Exp. Sta. Bul. 387, pp. 161-162) that although there is still a small but significant correlation between present size of tree in the orchard and size at setting, the environmental factors in the orchard have probably far outweighed any inherent genetic factors. The recent data are in agreement with previous findings. In connection with this study, 400 Washington-grown apple seedlings of grades two and three were set in the nursery row in nine replicated plots. The trunk diameters of these were individually measured at setting in May and again in October, 1940, after one season's growth in the new environment. A study of the growth of these supports the results obtained with larger orchard trees, even though two grades of nursery size were involved. A summary of the data is presented in tabular form on page 406.

Winter Injury to Apple Trees. Merle T. Hilborn. Most of the work is involved with hardy stocks to be top-worked to commercial varieties. Plantings have been made at Orono, Patten,

Nursery grade	Average diameter mm. May, 1940	Average diameter mm. Oct., 1940	Per cent increase in diameter	Ratio of October cross sectional area to May	Correlation coefficient (May vs. Oct. diameter)
2	4.46	9.96	123.1	5.0	.287±.044
3	3.07	8.26	168.7	7.2	.031±.048

and Highmoor Farm of Virginia Crab and various European apple varieties either supposed or proven to be hardy. At Orono several of these were top-worked to Baldwin, which has not been able to grow to any size here without complete winterkilling when worked on the ordinary stocks in the usual way. The top-worked Baldwin was uninjured in the spring of 1941 on Virginia Crab, while showing some injury on Hibernal and severe injury on Malling I, II, and XIII rootstocks. (Figures 2 and 3.) The injury on Hibernal was limited to growth beyond a point 12 to 18 inches from the bud or graft union, indicating possible transmission of hardiness from

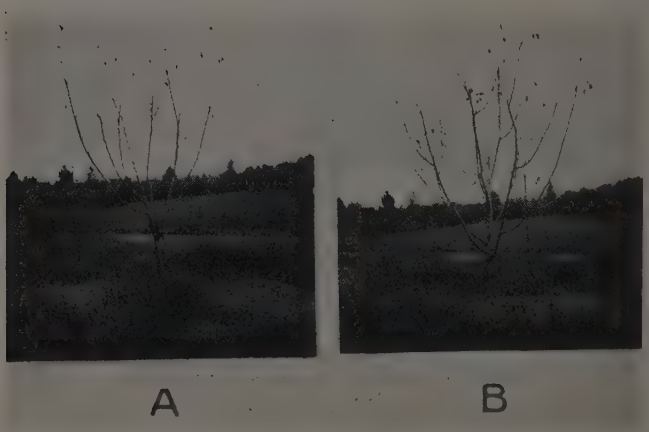

FIG. 2. Winter-killed Baldwin trees at Orono. Photographed in May, 1941. Notice the almost complete extent of the killing as only a few weak leaves appear. In A the rootstock is Malling II and in B the rootstock is Malling XIII.

the interstock through some of the Baldwin wood. The difference between Baldwin on Virginia Crab and Baldwin on Hibernal illustrates the need for tests of compatibility.

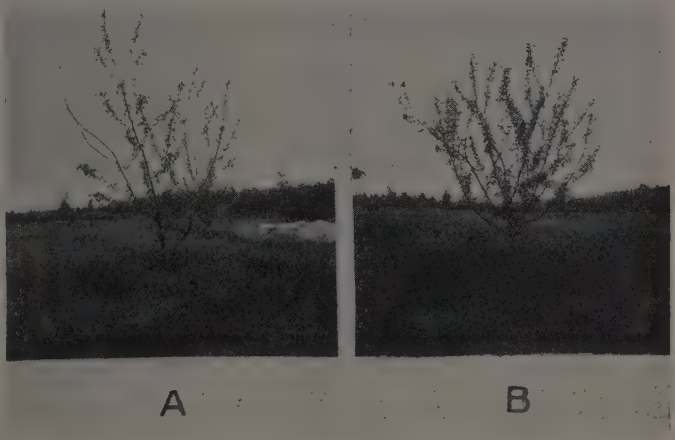

FIG. 3. Baldwin trees top-worked on hardy stocks. Photographed in May, 1941. Notice the comparatively good foliage on both trees. In A the tree is top-worked on Hibernal. Notice the one dead branch with a few leaves appearing near the crotch. In B the tree is top-worked on Virginia Crab. Notice the complete lack of winter injury.

At Orono 20 top varieties were worked on Virginia Crab, 5 on Hibernal, and some others on several clonal and seedling rootstocks. In the fall of 1940, measurements were made of the terminal growth of these scion varieties in order to determine what kind of growth was made on these various stocks. The terminal growth of 1940 was good, and there was no evidence of any dwarfing by the use of either Virgina Crab or Hibernal as an intermediate stock. When comparisons were made between the growth of the top variety on either Virginia Crab or Hibernal and the growth made on either a seedling or clonal rootstock, it was found that the hardy intermediate stock had invigorated the top variety. The growth was significantly greater in almost every case. Five top varieties were represented in this planting on both Virginia Crab

and Hibernal. When comparisons were made of the terminal growth of each of these varieties, it was found that in the case of Baldwin, Cortland, and Delicious the differences in growth were highly significant, favoring Virginia Crab. With Starking the difference likewise favored Virginia Crab, but fell just short of the standard of significance. With Northern Spy, the difference in terminal growth on the two trunk varieties was not significant.

Wood Rots in Winter Injured Apple Trees. In the spring of 1941, the alternate rows in the Golden Delicious orchard at Highmoor Farm were removed, consisting of a total of 148 trees. An examination of these trees showed 127, or 86 per cent, to have heart rot. In almost every case it was found that the rot had entered the tree through either a frost crack in the trunk or a winter injured crotch. If the data obtained in this orchard are typical of all Maine orchards, their owners may expect many of their trees to decline gradually and the main branches to break off under a load of fruit because of wood decay.

Hardy Stock Nursery. In 1940 a new cooperative association was formed by the orchardists of Maine. The purpose is to support a nursery that will produce hardy stocks for Maine orchards. At the present time it is planned to grow about 2,500 trees each year. Seedlings were set out in the spring of 1941 and these will be budded in the fall so that one-year whips will be ready for orchard planting in the spring of 1943. At the present time it is planned to produce mostly Virginia Crab, but as the research on hardy stocks continues a superior stock may be found. If so, it will be possible to propagate this stock rapidly for orchard distribution.

APPLE SCAB CONTROL. Donald Folsom. The effects of different spray and dust materials upon scab, growth, and yield were studied in two McIntosh apple orchards on Highmoor Farm in 1940.

Twenty-Seven-Year-Old McIntosh Trees. Two rows of trees have grown at equal rates since 1920; the average stem girth of the two differed less than one per cent since 1927. The spray treatment was identical for the two rows each year from 1920 to 1934 inclusive, after which one row received full-strength lime sulphur spray mixture and the other row received half-strength for four years. Finally both rows received identical treatment for the last two years. One effect of reducing the strength of lime sulphur

was to increase the yield the first year but this gain was offset by a reaction the second year. Another effect of the reduction in lime-sulphur strength was to reduce the cost of materials about 19 cents per tree, but this reduction allowed an increase in the amount of scabby fruit by nearly a bushel per tree. On the basis of these data a reduction in the strength of the lime sulphur spray is considered undesirable.

Young McIntosh Trees, Thirteenth Year. In 1940, 335 McIntosh trees set out in 1928 were given the final season's treatment with spray guns and duster. About 98 per cent of the trees blossomed and fruited with an average yield of two bushels. Five sets of plots received respectively four kinds of spray or dust treatment, with the same treatment in each set as in previous years. Some of the results of examining 2,000 leaves and 11,000 fruits are given in Table 1. Evidently the good scab control of previous years was continued with spraying, in which the lime sulphur or a "mild sulphur" was applied at the rate of about 2.6 gallons per tree in each of the seven applications. Sulphur dust did not control scab well, on account of the amount of dust being reduced from the average of 1.25 pounds used per tree in 1939 to 1.10 pounds per tree in 1940 per each of the seven applications.

The effects of the various treatments upon the tree and fruit, in addition to the results in Table 1, are given in Table 2. Evidently mild sulphur spray and sulphur dust had no effect on the amount of wood formed, as represented by trunk girth, while nearly doubling the yield rate. The increase in yield rate as a result of mild sulphur and sulphur dust treatments, as compared with lime sulphur treatment, was effected through an increase in the number of fruits per tree and not in fruit size. The great number of blossoms made it seem improbable that the observed differences in blossom abundance were responsible for differences in fruit number.

INSECTS AFFECTING THE APPLE CROP. Frank H. Lathrop. During the year ending June 30, 1941, studies were continued on the insect pests affecting apple orchards.

The Gypsy Moth as an Apple Pest. The gypsy moth (*Porthetria dispar* L.) continued to be a destructive pest in Maine apple orchards during the summer of 1940, and it was necessary for growers to protect their trees by timely applications of lead arsenate sprays. A study of the effectiveness of liquid spray in comparison with dust for the control of the gypsy moth showed that where the

TABLE 1

Current-Season Effects of Spray and Dust Materials on Apples, 1940

Treatment	Leaves		Fruits		
	Scabby	Burned	Scabby	Russeted	Clean
	Per cent	Per cent	Per cent	Per cent	Per cent
Dry lime sulphur 1928-1940	2.6	14.3	2.0	4.4	93.8
Dry lime sulphur 1936-1940	3.6	14.7	2.8	4.6	92.6
"Mild sulphur" 1928-1940;[1] micronized sulphur 1940	7.3	0.9	2.0	1.1	96.9
Bentonite sulphur dust 1928-1940[2]	12.6	1.8	24.9	2.3	79.6
Minimum requirement of lead arsenate[3] 1931-1940	33.3	3.0	93.7	0.7	6.3

[1] Flotation sulphur, bentonite sulphur, or micronized sulphur applied as a spray.
[2] Applied in 1940 at a lighter rate than in previous years when it controlled scab well.
[3] For tent caterpillar and gypsy moth; controls scab to some extent.

TABLE 2

Seasonal and Cumulative Effects of Spray and Dust Materials on Apple Tree Growth and Yield 1940

Treatment	Tree total 1940	Trunk girth 1940			Blossoms 1940[1]	Fruits 1940			Fruits 1933 to 1940 inclusive	
		Increase	Final	Ratio of final		Per tree	Ratio of yield rate	Number per bushel	Per tree	Ratio of yield rate
		Cm.	Cm.			Bus.[2]			Bus.[2]	
Dry lime sulphur 1928-1940	66	3.24	42.8	102.4	2.1	1.6	100.0	171	3.8	100.0
Dry lime sulphur 1936-1940; lead arsenate previously	65	3.62	43.4	103.8	2.1	1.5	93.8	173	4.0	105.3
"Mild sulphur" 1928-1940;[3] micronized sulphur 1940	65	3.29	44.0	105.3	2.7	3.0	187.5	190	7.2	189.5
Bentonite sulphur dust 1928-1940[4]	65	3.18	41.8	100.0	2.3	2.4	150.0	178	6.8	178.9
Minimum requirement of lead arsenate[5] 1931-1940; flotation sulphur previously	74	3.73	42.6	101.9	2.1	1.4	87.5	219	4.9	128.9

[1] Abundance of blossoms estimated in six grades from 0 (none) to 5 (most).
[2] A bushel is here considered as 44 pounds.
[3] Flotation sulphur, bentonite sulphur, or micronized sulphur applied as a spray.
[4] Applied in 1940 at a lighter rate than in previous years when it controlled scab well with the best cumulative yield rate.
[5] For tent caterpillar and gypsy moth; controls scab, which reduces yield, to some extent.

pink, calyx, and first cover applications were made, 90-10 sulphur-lead arsenate dust was less effective than 3 pounds of lead arsenate per 100 gallons, applied as a liquid spray. Preliminary tests and observations show that the effectiveness of the dust can be improved by increasing the proportion of lead arsenate in the mixture. The practicability of using dust mixtures containing high proportions of lead arsenate has not been fully ascertained.

The spring of 1941 was unusually early, and at Monmouth the first gypsy moth eggs were observed hatching on May 8, about eight days earlier than in 1940. Apparently there was a high percentage of mortality of the eggs during the winter of 1940-1941. Of the eggs under observation at Monmouth in the spring of 1941, an average of not more than one per cent hatched.

The failure of so many of the eggs to hatch resulted in a lower number of gypsy larvae as compared to former years, and in June, 1941, there was markedly less destruction than usual caused by this pest. The decrease in infestation was apparently greatest along an east and west line extending through Augusta and Buckfield. Southward, the decrease in infestation, though noticeable, became progressively less pronounced.

The Apple Fruit Fly (*Rhagoletis pomonella* Walsh). The emergence of flies at Monmouth in 1940 started on July 1, about five days later than average. Although it continued to be slightly late, the emergence throughout the summer as a whole continued to be nearer the average than has been observed in any season during the past 10 years. In 1941, the flies began to emerge on June 16, which is the earliest emergence recorded in observations covering 11 years.

A careful study of the rate of egg laying by the fruit fly was made in the summer of 1940. Examinations were made at weekly intervals of apples of several varieties, and the number of egg punctures found on each apple was recorded. The results of the study are summarized in Figure 4.

Experiments on the control of the fruit fly were continued during the summer of 1940. On a block of Red Astrachan apples, heavily infested with fruit fly, four applications were made of a commercial dust containing 0.25 per cent of rotenone. Although a liberal quantity of the dust was applied to the trees at each treat-

ment, and the applications were well timed, there was no noticeable reduction in the infestation.

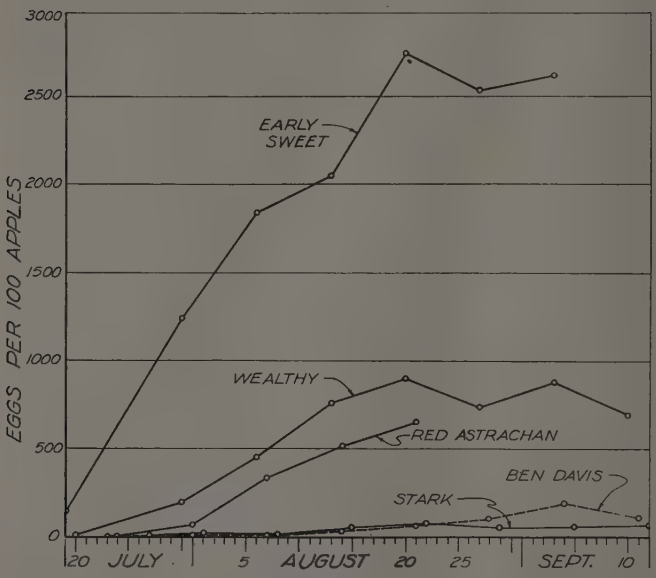

FIG. 4. Egg laying by the apple fruit fly in unsprayed apples at Monmouth, Maine, 1940. The curves show the increasing numbers of stings found in the apples as the season advanced. The early sweet apples suffered the earliest injury and the most extreme infestation of any of the varieties under observation. Wealthy and Red Astrachan show strong susceptibility. Late apples such as Ben Davis and Stark are relatively unattractive to the fruit flies. Notice that during the 30-day period from July 20 to August 20 the flies were most actively laying eggs in the susceptible apples. The study shows the importance of protecting against drifting flies until the end of the period of active oviposition.

CANNING AND GARDEN CROPS

SWEET CORN BREEDING. Russell M. Bailey and William B. Ennis, Jr. Approximately 1,500 plots were devoted to the improvement of breeding stock and production of experimental hy-

brids. Particular emphasis is being devoted to the development of inbred lines of Purdue 1339 type, which are of earlier maturity and better adapted to the cool spring soil temperatures typical to Maine. The prepotency of breeding stock is studied by top crossing with open pollinated varieties and by crossing with other unrelated inbreds.

A study is in progress on the variation in different types of sweet corn crosses. The potential economy of seed production of three-way crosses together with the excellent performance of certain parental combinations appears to warrant careful study of this type of cross in the commercial field. In the 1940 season, single, double, and three-way crosses were studied intensively for variability of silking date, pollen dehiscence date, plant height, ear height, ear length, ear diameter, ear weight, and number of kernel rows. Four inbred lines were combined in all possible combinations for this phase of the study. It was found that the three-way crosses as a group were more variable than single crosses, but more uniform than double or top crosses. Certain three-way combinations were almost as uniform as single crosses. The prepotency of the pollen parent and the similarity in certain characters of the two inbreds combined to produce the F_1 parent are the two important factors to consider in producing desirable three-way crosses.

A graduate fellowship established in 1936 by the Maine Canners' Association has aided in the research program and has enabled the Experiment Station to provide technical assistance to Maine packers in the production of hybridized seed. In 1940 about 1,000 bushels of hybridized seed was produced cooperatively by the Maine Canners' Association. In the spring of 1941 acreage for about double this quantity was planted. Seed of one new single cross is in commercial production this year for the first time to provide an extensive commercial trial in 1942.

BEANS. *Effect of Planting Rate on Yield and Grade of Snap Beans.* Iva M. Burgess. Full Measure beans were planted so as to obtain spacings of one, two, three, four, five, and six inches between plants, the study having been carried on for three seasons. In general it may be said that the yields from the one-, two-, and three-inch spacings were about equal. Wider spacings gave reduced yields. When harvested at two-day intervals, the percentages of U. S. No. 1 pods show only slight variations because of planting rates. In a dry season and under poor growing conditions,

the closest plantings gave more culls in the form of short, crooked pods, but when growth was good there was no evidence of this effect. There was no appreciable difference in earliness because of planting rates, but the crop from the closest plantings was bulked more narrowly in the earlier pickings, while that from the three-inch spacing and above was spread more uniformly over the picking period. Yields and returns at the current rates for the seasons are summarized as follows:

Yields and Returns, on Acre Basis, from Different Planting Rates Two- and Four-Day Pickings Combined

	1"	2"	3"	4"	5"	6"
Pounds U.S. No. 1 pods	7,600	7,371	7,288	6,796	6,375	5,864
Per cent U.S. No. 1 pods	72.6	70.7	70.6	70.5	69.2	68.1
Pounds U.S. No. 2 pods	2,140	2,206	2,266	2,034	2,122	2,050
Pounds culls	386	570	459	400	315	258
Per cent culls	3.7	5.5	4.4	4.2	3.4	3.0
Total	10,470	10,421	10,325	9,637	9,206	8,614
Value	$213	$208	$209	$200	$185	$171
Pounds seed required*	163	82	54	41	34	27

* Amounts based on size of seeds used in 1940 and considering a 90 per cent germination.

Effect of Harvest Interval on the Yield and Grade of Snap Beans. Iva M. Burgess. This experiment was combined with the planting rate experiment so that full replications of six rows each of six different planting rates were harvested at two-day and at four-day intervals. The effect of the different picking intervals on yield has varied with the seasons. In general, however, the total yield was lower for the plots picked at two-day intervals than for plots picked at four-day intervals. On the other hand, the percentage of pods grading U. S. No. 1 was higher from the two-day pickings so that this method resulted in a higher cash return. A cautionary statement may be made concerning the tendency of some pickers to harvest pods that are much too small when harvests are made at short intervals. This practice obviously results in the obtaining of lower yields.

Following is a summary of yields on an acre basis of Full Measure beans harvested at two-day and four-day intervals:

Bean Breeding. Iva M. Burgess and Russell M. Bailey. The work to develop a slender podded, white seeded snap bean for canning was continued in 1940. Wax and green podded selections

	1938		1939		1940		Average 3 years	
	2-day	4-day	2-day	4-day	2-day	4-day	2-day	4-day
Pounds U.S. No. 1 pods	4,517	4,190	7,227	7,298	9,884	8,178	7,209	6,555
Per cent U.S. No. 1 pods	66.7	62.6	81.8	71.2	85.7	65.9	79.7	67.0
Pounds U.S. No. 2 pods	1,760	1,870	1,164	2,440	1,523	4,061	1,481	2,790
Pounds culls	494	638	446	514	121	176	354	443
Per cent culls	7.3	9.5	5.0	5.0	1.0	1.4	3.9	4.5
Total	6,771	6,698	8,833	10,252	11,528	12,415	9,049	9,788
Value	$161	$154	$203	$209	$245	$214	$203	$192

are in the process of purification and under test for quality and adaptation.

The work to develop a productive bush type Old Fashioned Yellow Eye resistant to anthracnose was continued.

The Mexican Bean Beetle. John H. Hawkins. The Mexican bean beetle is now abundant and destructive in many Maine localities. During the spring and summer of 1940, the spread over the bean growing districts continued and considerable loss occurred in some localities because of injury to beans caused by this pest. During early June of 1941 the beetles were active in many places. The beetles began feeding on beans as early as June 10 in central Maine. By June 12, eggs were being laid on the young bean plants and a few young larvae were present on June 19. Judging from the number of beetles present and their early seasonal appearance, it seemed that an increase in injury and spread was likely to occur.

Work with insecticides for the control of the Mexican bean beetle was continued and the effect of materials used on the beans is shown in Table 3.

The treatment with a mixture of calcium arsenate and magnesium lime, as shown in Table 3, plot 1, results in an increase in the yield of beans as compared with the yield from untreated plots. The yield from plot 1 is greater than that from plot 2 also, in which the difference in treatment is only the substitution of calcium lime for magnesium lime. The mixture of calcium arsenate and magnesium lime (plot 1) is economical and practical for beans under many circumstances. In plot 3 the treatment consisted of the use of copper magnesium lime dust as a carrier or diluent for the calcium arsenate. Here is represented an increase in yield of dry beans as compared with the check and the treatment of plot 4 where the treatment was the same except that calcium lime was used in place of magnesium lime. In plot 5 the treatment consisted of

calcium arsenate and magnesium talc as the diluent. The results recorded under plot 6 show an increase in yield, and there is the possibility of the use of basic copper as a substitute for the ordinary copper sulfate. The use of Cryolite and magnesium talc recorded in Table 3, plot 12 shows an increase in yield of beans as compared with the check plots. Cryolite combined with flour was used successfully in plot 13 and was one of the best materials to use from the standpoint of mixing and applying. Cryolite is somewhat more expensive from the standpoint of cost per pound and amount necessary to effect control of the Mexican bean beetle than is calcium arsenate.

Of the materials used as sprays in plots 7 to 10, plots 7 and 8 indicate increases in the weight of dry beans as compared with the checks. The weights of beans as recorded under plots 9 and 10 are less than those of the checks and both of these plots contained wetting-spreading agents. This effect in reducing bean yields has been noted during previous years when the so-called wetting and spreading agents have been used. The effect was noted also when a wetting-spreading agent was added to rotenone dust, plot 11. Rotenone dusts without wetting and spreading agents are effective against the Mexican bean beetle and are safe to use on beans both from the standpoint of injury to the beans and human safety.

Results obtained over a period of years indicate that there is likely to be a reduction in yield of beans whenever a wetting and spreading agent is used. Even some materials which have been used as diluents for dusts and which when wet caused the calcium arsenate to adhere to the foliage have resulted in defoliation of the bean plants.

A previous report (Me. Agr. Exp. Sta. Bul. 400, p. 205) has shown that the use of magnesium lime with calcium arsenate resulted in increased yields of dry beans. This agrees in general with this year's results as shown in Table 3, plots 1, 3, and 5. The use of magnesium lime in dusts applied to beans for the control of the Mexican bean beetle is to be especially recommended where calcium arsenate can be used without danger to consumers. It is considered safe to treat beans with either calcium arsenate or Cryolite before the pods are formed. There is some danger involved in treating snap beans after the pods are formed unless it is certain that the calcium arsenate or Cryolite is removed before the beans are offered for consumption. In case of doubt, it is better to use

a less dangerous insecticide, such as rotenone, after the beans are set on the vines. Beans to be harvested as dry beans can be treated with calcium arsenate since the pods are not eaten.

The use of copper sulfate in sprays and dusts applied to beans appears to have an alleviating effect on the burning often caused when calcium arsenate is applied to bean foliage. This is in addition to whatever value it may have in repelling insects, controlling disease, or stimulating plant growth.

TABLE 3

Effect of Insecticides on the Yield of Beans During 1940[1]

Plot No.	Material used	Yield in terms of pounds per acre of dry beans		
		Treated	Untreated	Increase
1	Calcium arsenate 1 part, magnesium lime 7 parts	968.00	882.71	85.29
2	Calcium arsenate 1 part, calcium lime 7 parts	874.10	1,174.47	—300.37
3	Calcium arsenate 1 part, copper magnesium lime (20-80) 7 parts	1,059.47	904.12	109.35
4	Calcium arsenate 1 part, copper calcium lime (20-80) 7 parts	877.39	1,043.50	—166.11
5	Calcium arsenate 1 part, magnesium talc 7 parts	734.29	915.92	—181.63
6	Calcium arsenate 1 part, wheat flour 15 parts, basic copper 12 parts, pyrophyllite 72 parts	1,180.86	1,040.30	140.56
7	Calcium arsenate 1½ pounds, Bordeaux mixture with magnesium lime 50 gallons	1,132.94	1,050.54	82.40
8	Calcium arsenate 1½ pounds, Bordeaux mixture with calcium lime 50 gallons	1,000.49	907.20	93.29
9	Calcium arsenate 1½ pounds, magnesium lime 1½ pounds, wetting-spreading agent ½ pound, water 50 gallons	871.00	1,139.33	—268.33
10	Calcium arsenate 1½ pounds, calcium lime 1½ pounds, wetting-spreading agent ½ pound, water 50 gallons	991.32	1,230.90	—239.58
11	Rotenone 1%, talc 97%, wetting-spreading agent 1%	975.35	1,003.04	—27.69
12	Cryolite 1 part, magnesium talc 3 parts	1,164.88	1,037.11	127.77
13	Cryolite 1 part, wheat flour 3 parts	1,196.83	1,029.65	166.18

[1] The materials listed above containing calcium arsenate and Cryolite are poisonous to human beings, and should be used on bean plants only before the pods are formed, or on beans intended to be used as dry beans. Bean straw or refuse from beans treated with such poisons should not be fed to livestock.

CUCUMBERS. *Breeding Cucumbers Resistant to Scab (Cladosporium cucumerinum).* Russell M. Bailey and Iva M. Burgess. Maine No. 2, although inferior to most commercial varieties in type, is of high table quality and exhibits a high degree of resistance to scab. Most growers find it satisfactory for home use. A new white spined selection was under cooperative trial with growers last year but does not appear sufficiently outstanding for continua-

tion. New selections developed through a series of back crosses are definitely of better type and color. Additional commercial varieties have been tested for resistance to scab, but all were found to be highly susceptible.

Control of the Striped Cucumber Beetle. John H. Hawkins. Experiments in the control of the striped cucumber beetle were continued during 1940 with a view to testing various control methods and materials for efficiency in control. Due to the difficulties involved, it is not recommended that farmers mix insecticidal dusts for the control of the striped cucumber beetle unless the individual is willing to get together apparatus of such a nature that a thorough job can be done and is able to give time and thought necessary to do a good job. Where materials can be stored safely, purchase previous to the time of their use and at a season when the grower is not rushed, is recommended. Some of the more stable of the dust mixtures could be prepared during winter or early spring at a saving to the grower. Where water sprays are used, they should be mixed at the time of application but necessary spray materials should be purchased in advance of their use. Regardless of whether dusts or sprays are to be used, it is desirable to purchase materials ahead of time, especially those which have to be ordered from away and where there is likely to be a scarcity of the insecticides needed.

Protection from this insect early in the season when the plants are small and easily destroyed by striped cucumber beetles often is essential to obtaining a stand. Control of the beetles up to the time that cucumbers have set on the vine is advisable since it gives direct protection to the plants and is an aid in the control of the wilt disease which, after a period of incubation inside the striped cucumber beetle, is introduced into the plants by the beetles feeding upon the vines.

Injury is caused to the roots of squash and cucumber plants by the larvae of the striped cucumber beetle which hatch from eggs laid by the adult beetles. Keeping the beetles off the plants early in the spring often prevents this injury. Small screen wire or cloth cages sometimes are used effectively to protect the plants from adults during early spring and later from the larvae but are impractical after the plants have developed runners.

Lead arsenate and calcium arsenate have been widely used as insecticides to control the striped cucumber beetle. They are effective when combined with certain materials. There is some danger

of injury to the plants from the use of these materials when combined with hydrated lime and neither lead nor calcium arsenate should be used (when cucumbers are set) on the vines unless the cucumbers are peeled or otherwise cleaned of arsenical residue before being served.

Where it is necessary to treat cucumbers after the fruit has set on, it is a safe practice to use rotenone (in either dust or spray) as it is practically harmless to warm-blooded animals.

Dusts and sprays should be applied to the plants often enough to protect the cucumber plants, the number of applications depending in a measure upon the rainfall and general weather conditions. Sometimes the striped cucumber beetle is very scarce but it is never safe to assume that it will be entirely absent, for a relatively few may cause a great deal of injury.

Yields shown in Table 4 are total season yields of cucumbers from plots of three plants each, replicated 10 times. Dusts were applied during the time when the plants were moist with dew. Sprays were applied when the plants were relatively free from moisture. All dusts and sprays were applied four times during the season.

The results agree in general with results obtained with the same or similar materials during previous years. An exception is recorded under Plot 1 in which the plants dusted with calcium arsenate and a copper-lime dust, the lime containing magnesium, show a seasonal yield of three pounds less than the yield from Plot 2 in which lime practically free from magnesium was used in the copper-lime dust containing the calcium arsenate. This is contrary to previous results obtained in which magnesium lime in sprays and dusts has caused less injury to vines than where hydrated lime free from magnesium was used.

Compared with others, the yield for Plot 3 (recorded in Table 4) is greatest. This indicates that the talc containing magnesium is one of the best diluents for calcium arsenate when used on cucumbers.

The use of a wetting and spreading agent in cucumber dusts (Plots 4 and 6) resulted in a marked burning effect on the foliage of the plants during the season and a relatively low total yield of cucumbers.

The combination of insoluble copper, wheat flour, and pyrophyllite in which rotenone was the active ingredient (Plot 7) was

TABLE 4

Weights of Cucumbers Picked from Experimental Plots in 1940

Plot No.	Treatment	Pounds of cucumbers harvested
1	Calcium arsenate 1 part, 20-80 copper-lime dust (lime containing magnesium) 15 parts	28.7
2	Calcium arsenate 1 part, 20-80 copper-lime dust (lime free from magnesium) 15 parts	31.7
3	Calcium arsenate 1 part, magnesia talc 15 parts	41.7
4	Calcium arsenate 1 part, magnesia talc 14 parts, sodium lauryl sulfate 1 part	19.9
5	Check, no treatment	34.2
6	Four per cent rotenone (derris root) 25 parts, sodium lauryl sulfate 1 part, magnesia talc 74 parts	32.4
7	Four per cent rotenone (derris root) 20 parts, insoluble copper 18 parts, wheat flour 15 parts, pyrophyllite 47 parts	37.7
8	Calcium arsenate 1½ pounds, copper sulfate 5 pounds, hydrated lime high in magnesium 5 pounds, water 50 gallons	36.6
9	Calcium arsenate 1½ pounds, copper sulfate 5 pounds, hydrated lime 5 pounds, water 50 gallons	31.8
10	Check, no treatment	33.5
11	Calcium arsenate 1½ pounds, insoluble copper 2½ pounds, wheat flour 2½ pounds, water 50 gallons	36.8
12	Check, no treatment	27.3

generally satisfactory and shows some promise where the use of a fungicidal and insecticidal combination dust is desirable.

TOMATO BREEDING. Iva M. Burgess. A few lines showing desirable characteristics for an early variety are ready for preliminary trial in other locations. Selection is being continued among the progeny of crosses made to develop a tomato of good quality sufficiently early for northern Maine. Further studies are being made of the possible value of F_1 hybrid seed for commercial use.

VARIETY TRIALS OF VEGETABLES. Iva M. Burgess. Variety trials were grown at Highmoor Farm in Monmouth, Kennebec County; in Cape Elizabeth, Cumberland County; and at Kennebunk, Saco, and Kennebunkport in York County. Crops receiving the most attention were lettuce, tomatoes, carrots, snap beans, cabbages, muskmelons, and watermelons, with small plots of peppers, eggplants, broccoli, and lima beans. Results indicate that Imperial 44 and Imperial 847 are the most dependable heading lettuce varieties under Cape Elizabeth conditions. Certain strains of New York 515 also produced well, as did some selections from the U. S. Department of Agriculture Horticultural Field Station, La Jolla,

California. At Kennebunk, Stokesdale tomato was outstanding because of its yield of first-grade fruit and quality. At Cape Elizabeth, Marglobe seemed desirable for use as a late maturing tomato. Some excellent fruit from Rutgers was obtained, but it showed too much variation in size. Melon trials indicate that although Sweet Sensation and Early Canada were slightly the earliest maturing watermelons, Dakota Sweet, Tough Sweets, and Honey Cream were of better quality and sufficiently early for Maine growers. In a comparison of the earlier varieties of lima beans, including the small baby potato types, the various strains of Henderson are the most dependable. Imperator carrot produced desirable crops for either bunching or cut carrots.

Pea Aphid Investigations. John H. Hawkins. Pea aphid infestations on canning peas during 1940 were relatively light. A few fields in central Maine were affected so that commercial loss occurred, but on the whole the use of insecticides to control aphids was not essential in the production of canning peas.

Work with insecticides for the control of pea aphids was continued and Table 5 shows the percentage of control obtained from the several sprays and dusts used.

On the basis of the percentage of aphids killed, acetone extract of derris (Plot 1) used as a spray was the most effective insecticide used in these experiments. Derris spray C (Plot 3) was somewhat less effective. Atomized oil containing derris and nicotine (Plot 4) was slightly more effective than derris spray B. The advantage of the treatment under Plot 4 is that of lighter load in the field, the quantity of oil necessary to treat an acre being very small as compared with water sprays.

Rotenone dusts used for pea aphid control studies are listed in Table 5 under Plots 5 to 10. The use of two per cent rotenone in Plot 5 gave somewhat better control than was obtained in Plot 6 where one per cent rotenone with sulfated alcohol was used as a wetting and spreadng agent. The value of a wetting and spreading agent is shown by comparing the results obtained from Plot 6 with Plot 7. The dust used in Plots 6 and 7 was the same except that the wetting and spreading agent was omitted from the dust used in Plot 7. Table 5 shows that no control was obtained in Plot 7 where a one per cent rotenone without the wetting agent was used. Most effective of those used is listed under Plot 10. Apparently the increased effectiveness of this dust is due to the presence of

TABLE 5

Control Obtained from Insecticides Used in Pea Aphid Experiments During 1940

Plot No.	Treatment	Percentage of aphids killed
1	Acetone derris extract, vatsol and water	70.7
2	Derris spray B, a commercial preparation	41.2
3	Derris spray C, a commercial preparation	65.0
4	Atomized oil containing derris and nicotine	40.5
5	Derris dust to make 2 per cent rotenone, 1 per cent sulfated alcohol, remainder Celite and talc	42.8
6	Derris dust to make 1 per cent rotenone, 1 per cent sulfated alcohol, remainder Celite and talc	38.1
7	Derris dust to make 1 per cent rotenone, remainder talc	00.0
8	Derris dust. A commercial preparation	00.0
9	Derris dust to make 1 per cent rotenone, terpene ether 4 per cent, sulfated alcohol 1 per cent, remainder Celite and talc. A commercial preparation	47.6
10	Derris dust to make 1 per cent rotenone, terpene ether 4 per cent, sulfated alcohol 1 per cent, remainder Celite and talc	61.9

terpene ether in addition to the wetting spreading agent, sulfated alcohol. Derris dust as used in Plot 9 was identical with that used in Plot 10. Aphids were more plentiful in Plot 10 than they were in Plot 9 and this difference in population may have been responsible for the lower kill of aphids obtained from the insecticide as used in Plot 9.

Conclusions drawn from the past year's work, necessarily limited as to scope, point to the possibility of the value of terpene ether as an activating agent when used in derris dusts containing sulfated alcohol and Celite and talc as the diluents.

Present as usual in many pea fields during the summer and fall of 1940 was the disease which so effectively controls the pea aphids when they become abundant. Each year for the past ten years the aphids have been greatly reduced in number, and in many fields the pea crop has been saved by the destruction of the aphids by this disease.

Seasonal collections of the pea aphids have been made each year since 1937 in order to study the relationship of aphid abundance at various times of the year to outbreaks on canning peas. In general, it has not been possible to forecast accurately an outbreak, because during the past seven years severe aphid injury has not

been widespread in Maine. Pea aphid populations during this time have built up to potential outbreak proportions only to disappear through natural controls, chiefly through the activities of predaceous insects, parasitic fungi, or bacterial diseases. It is apparent from such data as are at hand that pea aphid outbreaks do not always follow even when the aphid population becomes great at about the time the peas are in full blossom. Serious injury to canning peas such as has occurred during the past several years has been due to the aphid population reaching outbreak proportions before the pods were fully formed and when at the same time natural checks on pea aphids were for some reason ineffective. If at the time insect parasites and predators and fungus or bacterial diseases are not present or are for some reason ineffective, and conditions are favorable to rapid aphid multiplication, it is then that injury to peas is most severe. It also is an observed fact that when pea aphid attacks occur early in the season natural controls are less likely to become effective in time to save the crop than when the aphid attack comes later when temperatures are higher and the vine growth of the peas is more dense than it is earlier in the season.

During the fall months of 1940, pea aphids were relatively rare in their customary overwintering habitat, the clover fields of central Maine. Very few aphids were to be found on clover during the early spring of 1941 and when infestations were found there was little indication of the winged individuals which fly from clover and start infestations on peas. Consequently up to July 1 only a few pea aphids were present in canning peas in central Maine.

Wireworms Affecting Field and Garden Crops. John H. Hawkins. The practical control of wireworms is possible with the use of proper crop rotation and cultural methods. However, those who grow crops of considerable value per acre could use chemicals, providing they were economical and would give quick control of wireworms. Such controls involve more expense than cultural controls and consist of working into the soil some substance poisonous or repellent to wireworms. Experiments with chemical control of wireworms during the spring of 1940 included the following materials: naphthalene, magnesium chloride, magnesium sulfate, carbon disulfide, dichloroethyl-ether, and calomel.

Data obtained indicate that wireworm control by the use of the soil insecticides so far tested is practical under Maine condi-

tions in the heavier soils, where wireworm infestations most frequently occur, only when the soil temperature is high and the moisture content low. The use of soil insecticides to control wireworms may be justified in the lighter soils on such rare occasions when wireworms are troublesome. Even in the lighter type of soils the soil should be warm and dry in order to obtain satisfactory control of wireworms by the use of chemicals.

Probably calomel and dichloroethyl-ether are the most promising of the new materials used in experiments with the chemical control of wireworms.

CHEMISTRY

WORK OF INVESTIGATION. Elmer R. Tobey, Bernie E. Plummer, Jr. The work of this department is cooperative with members of other departments in the Station and includes the chemical analyses in connection with some of the research projects. The results of these analyses are incorporated in the published reports of the respective Station research projects.

Chemical Analyses in Connection with Problems of Nutrition and Growth of Poultry, Dairy Cattle, and Other Animals. (In cooperation with the Department of Biology.) Analyses have been made upon samples of milk from the dairy herd at Highmoor Farm, samples of the ingredients used in making the rations for the experimental work with dairy cattle and poultry, samples of clippings taken from the pasture paddocks at Highmoor Farm, and samples of various varieties of grasses, legumes, and cereal grains grown upon soils of high and low levels of fertility.

Analysis of Materials Used in Connection with the Permanent Rotation and Fertility Experiments at Aroostook Farm. (In cooperation with the Department of Biology.) During the last year the work on this project has consisted in the analysis of the ingredients used in making the fertilizer mixtures which were applied to the experimental plots.

Strength of Mercuric Chloride Solutions in the Treatment of Seed Potatoes. (In cooperation with the Department of Plant Pathology.) This investigation has been in progress since 1937. In addition to the usual hydrochloric acid dip solution, an acetic acid dip solution was tried. Samples of these mercury dipping

solutions from two series of 0.2 per cent bichloride of mercury solutions, one acidulated with 0.5 per cent hydrochloric acid, the other with 1 per cent acetic acid, were analyzed to determine the acid and mercury concentrations. Each series extended through thirty consecutive dips without further addition of acid or mercury.

The results of the work in 1940 substantiate the previous results indicating the value of hydrochloric and acetic acids in the conservation of the mercury in the dipping solution and the saving of time in the dipping operations. The effectiveness compared favorably with that obtained by the nonacid soaking method.

The commercial application of acid mercury dip solutions for the treatment of seed potatoes, based on recommendations from the results obtained under this project, is in use in Aroostook County, Maine. This has resulted in a financial saving to the grower over the nonacid soaking method as it is not necessary to add mercury to the dipping solution during treatment.

The Conservation of Ammonia in Manure. (In cooperation with the Department of Biology.) The laboratory phase of the investigation dealing with the conservation of ammonia in farm manure, especially as it relates to the use of fermented manure in grassland and pasture improvement, has been continued.

DAIRYING

An Economic Study of the Dairy Industry in Maine. George F. Dow. *Dairy Farm Organization and Management.* Work during the year has been on the detailed analysis of the records of 989 dairy farms located in various areas of the State.

Milk Marketing. During the summer of 1940, information was obtained covering the marketing of milk and cream produced in Maine to ship to out-of-state markets. This information included the location and number of cows and heifers kept on each Maine farm producing milk for Massachusetts markets; quality regulations; bacteria counts and factors affecting quality; the volume, fat test, price, and number of producers each month from whom milk was purchased; country collection of milk, indicating cost and organization of collection routes; utilization of the milk in Maine; and transportation of milk and cream to Boston and other markets. The purpose of this phase of the study is to bring up to

date marketing information obtained about 10 years ago which was published in Station Bulletin 367, and to study trends, developments, and current problems of milk marketing. The information on the number of cows in each town shows the concentration of milk production available for out-of-state markets and indicates those areas adapted to large shipments of fluid milk. A comparison with similar data about 10 years ago shows important trends in intensity of dairying. Both producers and consumers are anxious to determine the effect of regulations on the quality of the milk and what improvements have been made in recent years. The reasons for differences in collection costs and the trend of such costs is of much importance to producers. Factors concerning the extent of and trend in seasonal variation of milk production will serve as a guide in the selection of an adequate price plan. Data on the trends in the volume of milk delivered per producer are of much importance in any consideration of milk production control. Information on the methods of shipping milk and cream to Boston indicates advantages and disadvantages of shipment by tank trucks and tank cars as compared with the earlier method of shipment by cans.

Milk Marketing in New England. (Cooperative between the U. S. Bureau of Agricultural Economics and the six New England Agricultural Experiment Stations.) Work on the study of the country milk plant has been completed, and publication of the results will be made in two parts, first, a mimeographed report on country plant location, etc., to be issued by the New England Research Council, and second, a printed bulletin to be issued by the Bureau of Agricultural Economics. This second publication will be devoted to an analysis of the Economies of Scale of Country Milk Plants. (R. G. Bressler, Jr.)

Field work has been completed on the study of country assembly of milk in northern Vermont and analysis of the data is in progress. (J. A. Hitchcock, W. E. Carpenter, and Alan MacLeod.)

Field work, together with some of the analysis, has been completed on the study of milk trucking in the Providence, Rhode Island, market. Publication is anticipated this fall and will probably be in the form of a mimeographed report issued by the New England Research Council. This may later be followed by a

Rhode Island Experiment Station bulletin. (J. L. Tenant and Alan MacLeod.)

A preliminary outline, indicating the scope and treatment contemplated in the summary report on the assembly of milk from New England milksheds, has been prepared. (Alan MacLeod.)

It is anticipated that following completion of these four projects, the work in milk marketing of the Boston office will be directed towards problems of consumption and distribution.

FAMILY ECONOMICS

HOUSEHOLD EQUIPMENT. Merna M. Monroe and Pearl S. Greene. *The Effect of the Method of Heat Application, and Accompanying Oven Conditions, upon the Flavor and Texture of Baked Foods.* The work has been chiefly that of perfecting techniques of controlling conditions and of measuring water-vapor content of the heated oven air in the study of the effect on baking with steam in the oven.

Testing of 1939–1940 Models of Electric Ranges Sold in This Territory. The work on this study has been completed and a popular report published in Maine Agricultural Extension Service Bulletin 293. The tests consisted of measuring the efficiency of heat transfer from top-stove units, the energy consumption to preheat empty ovens and to maintain a given temperature, the evenness of temperature distribution in the empty oven, and the baking of foods to note satisfaction of performance.

(1) When used to heat five pounds of water from 68° to 194° F. in a flat-bottom, covered pan, three makes of standard-size tubular units gave efficiencies of 75 per cent, 67 per cent, and 63 per cent; the ring unit, 63 per cent; and an open-coil unit, 48 per cent. The open-coil and the ring units show no improvement in efficiency of heating one kilogram of water as compared with those on the market six years ago; the present style of tubular unit is more efficient than when first made with the tubes rounded instead of flat on top. (See Me. Agr. Exp. Sta. Bul. 386.)

(2) The average energy consumption to preheat the ovens to 450° F. was 0.74 kw-hr.; to maintain this temperature for one hour, it was 0.67 kw-hr.

(3) Temperature measurements of the empty oven indicated that generally the front of the oven was somewhat cooler than the rear and that there was but little difference in temperature at three different levels in the oven, bottom, center, and top.

(4) Baking of foods, however, showed that the measurements of temperatures in the empty oven cannot be used as a basis for predicting actual baking performance. From the temperature measurements of the empty oven, one could not estimate the extent of unevenness of browning which would be obtained or know whether the difference would be chiefly in top or in bottom browning. One oven tested appeared to maintain suitable temperatures when operated with no food, but failed to provide sufficient heat during actual baking operations. The difficulty was due to faulty operation of the thermostat and not to insufficient heating capacity in the units.

Since actual baking is required to test the performance of ovens, there arises the problem of standardizing and controlling baking procedures, particularly recipes and methods of mixing, so as to separate these factors from those variations caused by the oven heat. A committee of household equipment research workers (on which this Station has a representative member) is working on specifications for performance-in-use tests of domestic cookstoves.

A Study of the Performance of Wood Ranges Heated by Distillate Burners and an Evaluation of Factors Which Affect Their Performance. One of the chief criticisms of the kerosene burners in the wood range is the slowness in heating the stove to suitable cooking temperatures. Some homemakers have complained of obtaining insufficient bottom browning of foods baked in the oven. Various possible causes of these difficulties were investigated. (See Me. Agr. Exp. Sta. Buls. 397 and 400 for description of the stoves being studied.)

(1) A cold draft at the floor of the room did not cool oven temperatures; such a draft had no effect on the temperatures of the steel range.

(2) A cold draft back of the steel range, where room air entered the firebox, reduced the stove temperatures appreciably. The flames diminished in height, particularly the flame of the rear

burner where the cold air entered the firebox. Since the height of the flames depends on the rate of evaporation of kerosene, and, other factors being equal, the rate of evaporation depends on the temperature of the metal in the burners, the decreased stove temperatures may be assumed to be due to the excess of cold air entering the firebox and cooling the burner sleeves.

(3) Somewhat higher oven temperatures and considerably higher top-stove temperatures were obtained from the steel range when the draft through the stove was reduced. A draft of 0.04 inch of water was normally used for this stove and for the cast-iron range. Apparently, this draft is excessive for the steel range, which has not only a poor-fitting oven damper but also considerably less baffling in the flue passage around the oven than does the cast-iron stove.

(4) Reduction of the height of the flue passage under the oven by putting sand on the bottom of this passage resulted in much higher top-stove temperatures and somewhat higher oven temperatures for the steel range, but had no effect on the temperatures of the cast-iron range. This suggests the possibility that the use of sand will be helpful only in those stoves which have little baffling in the flue passages to retard the flow of air.

(5) The maintenance of a greater depth of kerosene in the burner bowls of the steel range, five-eighths inch instead of one-fourth inch, gave somewhat higher stove temperatures. This is not a practical method of obtaining faster heating because the flames tended to smoke and the kerosene consumption was somewhat greater.

(6) Sufficient bottom browning of batters and doughs was obtained in these two ovens when the pans were placed on the floor of the oven. As could be expected, less bottom browning, and more top browning, was obtained when the pans were placed on the rack at the center of the oven. Although the bottom of the oven is at a lower temperature than the center or top, yet the thermal capacity of the metal in the floor of the oven is much greater than that of the baking rack or the air at the center of the oven; for this reason, more heat is transferred to the bottom of the pan when it is placed on the floor of the oven.

FARM CREDIT

FARM CREDIT IN MAINE. Charles H. Merchant. The manuscript on agricultural credit conditions in Aroostook County is being revised for possible publication. Information for this study has been obtained from farmers, credit agencies, and tax officials. The manuscript will contain information on (1) debt load of farmers in Aroostook County, (2) indebtedness of town governments, (3) credit agencies and their policies, (4) prices of potatoes and factors affecting potato prices, (5) variation in the costs of producing and the costs of marketing potatoes, (6) relation of various economic and physical factors to the ability of farmers to repay loans, and (7) suggested improvements in the use of credit by farmers and the extension of credit by credit agencies.

FIELD CROPS

SMALL GRAIN VARIETY TEST. Joseph A. Chucka and Arthur Hawkins. *Oats.* Ten varieties of oats (Eagle, Sovereign, Erban, Richland, Vanguard #7, Upright, Maine 340, Victory, Gopher, and Lenroc) were included in the oat variety test at Aroostook Farm in 1940. The varieties are listed in the order of their yields (highest to lowest).

The varieties of oats were planted at two different dates, May 14 and June 14. The average yield of the ten varieties planted on May 14 was 96.4 bushels per acre, while the same varieties planted on June 14 produced an average yield of only 66.5 bushels per acre.

Barley. Six varieties of barley (Alpha, Byng, Hannchen, Wisconsin #38, Velvet, and Oderbrucker) were included in the barley variety test at Aroostook Farm. The yields in 1940 for the six varieties were in the order listed (highest to lowest). The early (May 14) planting produced an average yield for the six varieties of 60.6 bushels per acre, while the late planting (June 14) produced an average yield of 49.7 bushels per acre. Byng, Wisconsin #38, and Velvet are smooth-awned barleys while the other three have barbed awns.

Wheat. Eight varieties of spring wheat (Garnet, Premier, Canadian R.L. 1005, Apex, Reward, Sturgeon, Thatcher, and

Rival) were included in the wheat variety test at Aroostook Farm. The 1940 yields for the eight varieties were in the order listed above (highest to lowest). These wheat varieties were planted on the same planting dates used for oats and barley. In the case of wheat, the date of planting did not affect yields as it did in the case of oats and barley. The average yield of the eight varieties of wheat was 25.3 bushels per acre for the early planting and 26.8 bushels per acre for the later planting.

Soybeans. Russell M. Bailey. In variety trials at Highmoor Farm, Manitoba Brown and Cayuga varieties were sufficiently early maturing to recommend for trial by Maine farmers interested in producing dried beans for feed. The first variety should mature its crop nearly anywhere in the State, but is not vegetative enough for hay or silage. Cayuga is more vegetative, is several days later in maturity, and may be used for either grain or silage depending upon the location.

Field Corn. Russell M. Bailey. Trials of field corn varieties and hybrids were conducted at Highmoor Farm in 1940. The results were not as reliable as in previous years due to an unfavorable season. However, the flint-dent crosses (reported in Me. Agr. Exp. Sta. Bul. 400, pp. 227-228, 1940) were again outstanding in early maturity and yield. Sufficient hybridized seed of these was produced to place them in cooperative trial with approximately twenty-five farmers in 1941.

FOODS AND NUTRITION

A Study of the Food Habits and Nutritional Status of Children in Selected Communities in Maine. Mary M. Clayton. During the past year the results of the four-year study of the food habits and nutritional status of the grade-school children in Newport have been summarized with the following objectives in mind:

1. To determine the changes which took place in the group during the period of the study (fall 1936 to spring 1940).
2. To determine the progress in growth of individual children during the four years.
3. To determine how the Newport children compared with those from Mars Hill, Jonesport, and Monmouth.

4. To determine how they compared with groups of public and private school children from various parts of the United States.

5. To evaluate the McCloy method of appraising physical status by the use of anthropometric measurements.

A few of the most outstanding findings are summarized briefly as follows:

Physical Defects. The physical defects found in the Newport children were very similar to those found in Mars Hill, Jonesport, and Monmouth. Those occurring most often were bone defects (resulting from rickets), flat foot, colds, inflamed gums, enlarged or infected tonsils, adenoids, defects of vision, and underweight.

Physical Measurements. Anthropometric measurements, according to the method of Dr. C. H. McCloy[1, 2] were obtained on the children fall and spring throughout the four years. In the spring of 1940, 49.0 per cent of the girls and 22.2 per cent of the boys were more than 6 per cent underweight by the McCloy Standards. Comparison of the fall averages for height and weight (sexes considered separately), secured each year, with each other and with those secured in other Maine towns in the fall of 1934 gave the following results:

1. The differences between the fall height averages for the children in the different years were not significant.

2. The fall height averages (four years combined) for the Newport children were significantly higher than those of the Jonesport children. They were not significantly different from the averages for the Mars Hill and Monmouth children.

3. The fall height averages did not show significant differences from the U. S. averages of Collins and Clark[3] but were significantly lower than those of the Iowa City children reported

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[1] Appraising physical status: the selection of measurements. Univ. of Iowa studies in child welfare. Vol. 12, No. 2, 1936.

[2] Appraising physical status: methods and norms. Vol. 15, No. 2, 1938.

[3] Physical measurements of boys and girls of native white race stock (third generation born) in the United States. Public Health Reports. Vol. 44, pp. 1059-1083, 1929. Reprint No. 1281.

by Meredith[4] and Boynton[5] and those of the private school children reported by Gray and Ayres.[6]

4. There was a significant difference between the fall weight averages for the girls in 1937 and 1939, the averages being lower in 1937. This was probably related to the fact that there was considerable unemployment in Newport in the fall of 1937. The averages for the boys did not show significant differences in the different years.

5. The fall weight averages (four years combined) for the girls were significantly lower than the United States, the Iowa, and Gray's averages. Those for the boys were not significantly different from the United States averages, but were significantly lower than the Iowa and Gray's averages.

Dental Defects. Caries was very prevalent, and decalcified areas, hypoplastic enamel, and malocclusion were seen frequently. The average number of cavities per mouth for the four years was 9.2 and the average number of fillings 1.6. This average for cavities in the teeth of the Newport children is slightly lower, and the average for fillings slightly higher than those obtained for the children studied in the other three towns.

Home Production of Foods. Information secured at home visits, made in the winter of 1937, indicated that 80.1 per cent of the Newport families had gardens, 16.9 per cent cows, and 15.4 per cent chickens; 15.4 per cent also raised animals for meat. Since 14.7 per cent of the families were rural and, in most cases were the ones who had the cows, chickens, and other animals, it appears that most of the village families were not doing much toward producing their own food except planting gardens, many of which were small. (In Mars Hill in 1934-1935 almost all of the families visited lived in the village, yet 91.4 per cent had gardens, 22.2 per cent cows, and 37.0 per cent chickens.) The vegetables and fruits most commonly raised by Newport families were: string beans, beets, carrots, corn, cucumbers, endive, lettuce, peas, rad-

[4] The rhythm of physical growth. Univ. of Iowa Studies. Vol 11, No. 3, 1935.

[5] The physical growth of girls. Univ. of Iowa Studies. Vol. 12, No. 4, 1936.

[6] Growth in private school children. The Univ. of Chicago Press, Chicago, 1931.

ishes, rutabagas, tomatoes, and raspberries. Those most frequently canned were: string beans, beets, corn, cucumbers (made into pickles), peas, tomatoes, blackberries, raspberries, and strawberries. Beets, carrots, potatoes, and rutabagas were those most often stored.

Milk Consumption of Families. Information was secured at the time of the home visits regarding the family consumption of milk. Comparison of the amounts of fresh milk consumed with the amounts considered necessary for good nutrition showed that Newport families were using 57.7 per cent of the total fresh milk needed.[7]

Diets of Mothers During Pregnancy. The diets of the mothers were frequently inadequate during pregnancy. The chief defects were the result of failure to consume sufficient milk, fruits, vegetables, and eggs. Although vitamin D is considered essential in the diet during pregnancy, no Newport mother who was questioned had taken cod-liver oil or any similar product containing vitamin D.

Diets During Infancy. A study of the diets of the children during their first year showed that 34.4 per cent were breast fed at least five months and 28.3 per cent at least nine months. These percentages are lower than those secured in the other three towns. Answers to questions regarding the foods fed other than milk indicated that 60.4 per cent had received orange juice; 38.7 per cent, cod-liver oil; 70.9 per cent, egg yolk; 85.6 per cent, vegetables; 47.4 per cent, fruits; and 87.4 per cent, cereals. These figures are all somewhat higher than those secured for the other towns, with the exception of that for orange juice which is slightly below this item for Mars Hill.

Preschool Diets. The data secured regarding the preschool diets did not give a great deal of information concerning their nutritive value as a whole. However, a question asking whether or not the children had "many sweets" was answered "yes" for 40.3 per cent of them. The average milk consumption was three cups per day, which is slightly higher than the averages secured in the other towns. The consumption of milk averaged two cups or less, however, for 35.7 per cent of the children. Only 27.4 per cent

[7] See Me. Agr. Exp. Sta. Bul. 401, p. 98, for milk consumption in three other Maine towns.

had received cod-liver oil (or similar source of vitamin D) regularly during the winter, at least until the age of three; 49.8 per cent had received none.

Diets During School Years. Diet records for one week (kept by the children) were secured in the fall of 1936, the spring of 1938, and the spring of 1940. The summaries of these records made thus far indicate that the general character of the diets did not change during the period of the study, although the diets of individual children varied with the time of year and with changes in the economic condition of families. (There was a great deal of unemployment in the latter part of 1937 and early part of 1938.) The records secured in 1936 and 1938 were compared with the standards for a minimum cost adequate diet proposed by Carpenter and Stiebeling.[8] In general most of the diets were satisfactory in their content of meat and fish, dried beans, and white potatoes, but many were low in milk, citrus fruits and tomatoes, leafy, green, and yellow vegetables, and other fruits and vegetables. Also, a considerable number were low in eggs and whole grain cereals. A comparison of the records for the two years showed that in the spring of 1938 the number of children who were receiving the standard number of potatoes and whole grain cereals was about the same as in the fall of 1936. A smaller number were receiving the standard amount of meat, milk, leafy, green, and yellow vegetables, and other fruits and vegetables; an increased number were receiving the standard amount of dried beans, eggs, citrus fruits, and tomatoes. The increased unemployment in 1938 probably explains the decreased consumption of meat and milk in the spring of that year. The decreased consumption of leafy, green, and yellow vegetables and other fruits and vegetables was no doubt largely due to the fact that many of the families had used up all of their home canned (and stored) fruits and vegetables and did not have sufficient income to buy more. Citrus fruits and tomatoes were used in place of locally raised fruits which were available in the fall. The increased use of eggs in the spring can be explained as due to the fact that eggs were cheaper than meat.

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[8] Diets to fit the family income. U. S. Dept. of Agr. Farmers' Bul. No. 1757, 1936.

The diet records for the spring of 1940 have not been compared with those of the other two years but Table 6 gives the results of a comparison with the standards for a "good diet" suggested by Stiebeling and Clark.[9] This table shows that the diets of approximately 40 per cent of the children were deficient in eggs, and that those of at least 60 per cent were deficient in milk, citrus fruits and tomatoes, leafy, green, and yellow vegetables, other fruits and vegetables, and whole grain cereals and breads.

The fact that enriched white flour has recently been put on the market will result in the provision of more of the minerals and vitamins which have been supplied in sufficient quantity only by the use of unrefined cereal products. However, more of the other foods mentioned as necessary can be supplied only by wiser buying on the part of housewives, by increased home production and preservation, and by the greater use of surplus commodities.

TABLE 6

Percentage of Newport Children Who Were Up to or Above the Standards for a "Good Diet" in the Following Food Groups

1 Milk	2 Potato and sweet potato	3 Citrus fruits and tomato	4 Leafy, green, and yellow vegetables	5 Dry legumes and nuts	6 Other fruits and vegetables	7 Eggs	8[1] Meat, fish, and poultry	9[2] Whole grain cereal and dark bread
28.5	70.8	20.0	6.9	95.4	29.2	57.7	64.6	37.7

[1] Extra foods in group 8 allowed to make up deficiencies in groups 5 and 7.
[2] Standard used, one serving per day.

In addition to being deficient in a number of the important food groups, the diets tended also to be too high in sugar and products made from white flour and low in vitamin D. (Only 10.3 per cent of the grade-school children were taking cod-liver oil or some similar source of vitamin D.) The use of too many sweet desserts and candy and the failure to consume sufficient milk, citrus fruits (or other foods high in vitamin C), and some product containing an adequate amount of vitamin D probably

[9] Food and life. Yearbook of Agriculture. U. S. Dept. of Agr., 1939. See p. 332.

have a great deal to do with the prevalence of dental caries and inflamed gums.

The Nutritional Status of University of Maine Freshman Girls as Related to Their Diets. Mary M. Clayton. This study is being made in cooperation with the Department of Physical Education for Women of the University of Maine and the State Department of Health and Welfare. Work on the project was begun in the fall of 1940 and will be continued for several years. The girls of the incoming freshman class who came from the State of Maine (total number 138) were given their usual physical examinations by a physician[10] and dental examinations by Miss Dorothy Bryant, Associate Director of Dental Health for the State Department of Health and Welfare. A short time later physical measurements (by both the McCloy and Hrdlicka systems), determinations of hemoglobin, red blood cell counts, strength tests, breathing capacity determinations, and posture studies were made. Diet records for one week were secured while the girls were at home during the spring vacation.

A partial summary of the results secured thus far indicates that, according to the McCloy standards, 21 per cent of the freshman girls were definitely underweight but only .7 per cent were definitely overweight. According to the nutritionist's estimate, however, 7.3 per cent were definitely overweight. This lack of agreement in the percentage of overweight girls suggests that the McCloy standards are too high for overfat individuals. (The same lack of agreement was noted in the Newport grade-school children.) Blood tests showed that 11.6 per cent had hemoglobins under 85 per cent of normal (14 gms. per 100 ml. of blood considered normal) and 4.4 per cent had red blood cell counts under 90 per cent of normal (4,500,000 considered normal). Also 38.4 per cent of the girls had acne.

Dental examinations showed the following:

Average number carious teeth per mouth	1.8
Average number filled teeth per mouth	9.1
Average number teeth both carious and filled per mouth	.9
Average number extracted teeth per mouth	1.2
Average number decalcified areas per mouth	1.4

[10] Dr. Harold E. Pressey of Bangor.

Diet records kept by 59 of the girls for one week during the spring vacation showed that although the diets were much better than those of the Newport children the general tendencies were the same. Results are given in Table 7.

TABLE 7

Percentage of Freshman Girls Who Were Up to or Above the Standards for a "Good Diet"[1] in the Following Food Groups

1 Milk	2 Potato and sweet potato	3 Citrus fruits and tomato	4 Leafy, green, and yellow vegetables	5 Dry legumes and nuts	6 Other fruits and vegetables	7 Eggs	8[2] Meat, fish, and poultry	9[2] Whole grain cereal and dark bread
61.02	74.58	81.36	55.93	98.31	77.97	84.75	100.00	30.51

[1] Stiebeling, H. K. and Clark, F. Food and Life, p. 332. 1939.
[2] Extra foods in group 8 allowed to make up deficiencies in groups 5 and 7.
[3] Standard used, one serving per day.

REGIONAL AND VARIETAL DIFFERENCES IN VITAMIN C CONTENT OF FOOD CROPS IN RELATION TO VITAMIN C STATUS. Elizabeth F. Murphy. *Crop Varietal Studies.* Analyses of Maine-grown fruits and vegetables for their contents of essential vitamins and minerals are being extended each season. For superior mass nutrition, it is important to determine for purposes of dietary and production recommendations, the availability of essential food factors. Currently, with stress laid on "nutrition for defense" and with indications of nutritional deficiencies being brought to light both among conscripted men and the population at large, the significance of accurate analytic data on foods is manifest.

During the past year a study of differences coincident with variety in the vitamin C values of Maine-grown onions was made.[11] Raw, fresh onions were found to contain significantly large amounts of vitamin C. This is especially true of small immature onions. Frequent use of young raw onions in soups and salads would provide a valuable vitamin C supplement to the diet. Relatively large decreases in the vitamin C content of onions were in-

[11] The ascorbic acid content of onions and observations on its distribution. Food Research. In Press.

curred during cooking. Short cooking periods aid in conserving this food essential. Losses during home storage were of such a magnitude as to render the stored onion of dubious value as a major source of vitamin C. An investigation of the vitamin C content of 15 varieties of cabbages and the effect of storage and cooking thereon is being continued.

In view of the scarcity of spinach seed this year, kale[12] was recommended as a substitute. During the summer of 1940, experiments have shown that raw Maine-grown kale is a superior source of vitamin C, with values over 30 mg. per ounce. This compares very favorably with lemons at 15 mg. and spinach at about 12 to 18 mg. per ounce. One serving of raw kale would adequately supply man's daily requirement of vitamin C. The carotene (vitamin A) content of kale also compares favorably with that of spinach. One test found the Dwarf Green Curled Scotch variety to contain approximately 4,000 International Units of vitamin A per 100 grams (nearly four ounces) which amount would furnish four-fifths of man's daily requirement. The vitamin A content of spinach has been reported as being from 4,383 to 10,833 International Units per 100 grams. Kale has been reported also as being relatively high in iron, available calcium, and riboflavin.

Kale may be eaten raw as a salad green or cooked in the same manner as spinach. If kale is to be cooked, either a short cooking time (five to ten minutes or until tender) in small amounts of boiling water or steaming is recommended. Long cooking tends to decrease its palatability and to lessen availability of vitamins and minerals. The center new leaves are superior in eating quality to the outer older leaves. As the plant is frost resistant, it may be harvested in this State through October and into November. The plants behave like chard in that some leaves may be cut and new growth will soon develop. Dwarf Green Curled Scotch is a very desirable variety from all viewpoints.

The results of an investigation of geographical variations in respect to vitamin C[13] emphasize the importance of analytic observations on locally-grown produce. In this study four varieties

[12] Not to be confused with the weed called "kale."

[13] Geographical Situation as an Influencing Factor in the Production of Ascorbic Acid (Vitamin C). Jour. Agri. Res. In Press.

of tomatoes were grown during 1938 and 1939 and four varieties of cabbages were grown during 1939 in four widely separated localities in the State to determine the effect of geographical situation upon the production of vitamin C. During 1938 it was found that the tomatoes grown in Aroostook were significantly lower in vitamin C than were those produced in Orono, Monmouth, and Kennebunk. During 1939, with the experimental procedure unchanged, the values of the Kennebunk-grown tomatoes were lower than were those for the tomatoes grown in Aroostook, Monmouth, and Orono. The observations made on cabbages in 1939 confirmed the results manifested by tomatoes. There is some evidence that sunlight and rainfall brought about these locality variations. Thus environmental agencies markedly influence the synthesis of vitamin C in tomatoes and cabbages. Therefore varieties of fruits and vegetables which are high in vitamin C are of greatest importance. A variety of tomato may be shown to contain 40 mg. of vitamin C per serving of tomato under optimum conditions, whereas another variety may contain only 20 mg. per serving under similar optimum conditions. If both these varieties are grown during a year when environmental conditions are such that vitamin C production is curtailed to only 50 per cent of optimum, it is obvious that a serving of the superior variety would furnish over one-quarter of the day's needs, whereas the inferior variety would supply only slightly over one-tenth of the requirement. Because of variations of this nature, it may be seen that superior nutrition for Maine people is specifically a regional problem.

Nutritional Status Studies. Studies on the vitamin C status of Maine individuals are of benefit in pointing out what kind of deficiencies exist, thereby indicating the direction in which a food production should be guided.

A dietary study, combined with clinical and laboratory observations, on 86 Maine school children was recently completed.[14]

During the summer of 1940 a second study was undertaken

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[14] Murphy, Elizabeth. A Study of Vitamin C Nutrition in a Group of School Children. II. Dietary Evaluation. Jour. Nutr. 21 (5): 527-539. 1941.

Crane, M. M. and Woods, P. W. I. Clinical and Laboratory Studies. New England Jour. Med. 224: 503-509. 1941. Abstracted p. 523 of this bulletin.

in which the Biology Department of the Maine Experiment Station cooperated with the Farm Security Administration on their medical survey in one of the counties of Maine. One phase of this cooperation involved the determination of the plasma ascorbic acid of the individuals who were examined. Although the interpretation of the data is still in a preliminary stage, the figures published by the Farm Security Administration[15] showed plasma ascorbic acid values below 0.40 mg. per cent in 38 per cent of the 276 men, women, and children examined. Values below this level have usually been found to be associated with vitamin C undernutrition. This large percentage of low plasma values is even more significant when it is considered that the observations were made during the latter part of July and the first part of August when vitamin C containing foods should be available in abundance from home gardens and at a low price in the markets.

A STUDY OF THE RELATION OF MAN AND OF ANIMALS TO THE ENVIRONMENT. VI. W. Franklin Dove. (a) *Food as a Commodity for Exchange and Its Relation to Malnutrition.* In primitive and in pioneer societies foods were produced for local or regional use. Under these conditions the home produced almost all of the different foods desired by the group. Today, the foods consumed in any one region include the produce received from numerous other regions of the country and even from distant regions of the world. In other words, foods have entered into national and international trade as a commodity for exchange.

The advantages which arise from this elevation in status of food from a home product to a world commodity are for our present purposes at least twofold: (1) money exchange is secured and (2) extra or new nutritional values are made available from the imported foods when supplementing the foods produced and consumed locally. From the first, money exchange, may arise better opportunities for an increased standard of living and for the purchase of foods not produced locally. From the second attribute, new nutritional factors from imported foods, there may be secured a stimulus to better nutrition. Thus when foods were graduated from the classification of a home-product to that of a national- or world-commodity, the advantages which it was hoped would accrue to both producer and consumer were to be in terms of more money

[15] Science News Letter 39:341-342. 1941.

exchange and better nutrition. Such too were the ultimate hopes of results to accrue from the scientific study of nutrition.

In order that these recognized advantages of foods as commodities actually accrue to society there are several problems in the bioeconomics of food-production with which the nutritionist as well as the producer must be concerned. When foods are produced as a commodity for exchange every step in the process must have the inducement of the so-called "profitable return": a profit simplified in terms of interest, wages, and residual, one or all, as one of the powerful inducements of enterprise must be reasonably assured or expected either from the particular transaction or from some other transaction. Under the necessities of commodity transactions food-crop production, from the selection and planting of seeds, through the care and cultivation of the soil, management, harvest, storage, distribution, and, finally, to the delivery of the food to the home, forms a series of events or of transactions, each of which must give someone some degree of hope that a profit will accrue and at the same time assure a minimum of expressed dissatisfaction from the receiver or consumer of food. There are several exceptions to the foregoing statement since sometimes foods are produced as a hobby regardless of expense, while home-cooked foods may have appetitive and satisfaction values on and beyond the cost of preparation; but on the whole, the mass production of food for the mass of population must go through the system of barter or exchange from one to six or more times before the selected seed is transformed into the delectable dish of food and in turn into available nutrients or into values of food-satisfaction.

The results of contemporary nutritional research indicate that a loss in nutrient value may occur during any one of the transactions in food commodities. In order, then, to protect profit in the transaction (which generally is allowed to take care of itself under free competition) and also to protect nutritional value of the food commodity (which may or may not be preserved by present methods), a large field of nutritional research remains to be explored. Thus, for instance, nutritional changes which may have taken place as foods enter into the market as commodities consist in dilutions (expansions in quantity of yield at the expense of quality); over-refinement; selections based upon eye appeal; and selections based upon resistance to disease, to insect damage, to long storage, and to extreme changes in temperature. Many of these selections if

directed on the basis of market exchange value alone may have an undesirable effect upon and a negative association with the nutritive value of the food.

Specific examples of the disagreement previously assumed between market value and nutritive value of foods based on present knowledge are numerous: Large quantity yields have been, at times, associated with low carotene content in corn, millet, and wheat;[16] refinement of foods may prevent insect damage and retard autocatalytic chemical processes and if so it is thereby of value for long distance transportation and for storage but it may result in low-mineral, low-nutrient values of the foods refined. Most of these causes of loss in nutritive value of commodity foods are becoming common knowledge.

Other associations between the production of commodity foods and nutrition are less obvious and are less subject to experimental proof and yet they may be equally important to nutritional status. In this we refer to the possible inter-relation between over-specialization—mortgage debt—and nutrition dealt with in a previous report of this series.[17] Such studies as these are prerequisite to clearing the way for the projection of some intelligible approach to the elimination of malnutrition. These facts should be of equal value both to the producer of commodity foods and to the consumer of food, and the present report deals particularly with an extension of this problem in terms of suggested practical correctives.

In order to appreciate fully the nutritional and economic difficulties involved and in order to indicate a way out, a distinction should be made between foods produced for the commodity market and foods produced for physiological use. In some respects this distinction between market foods and foods for use may seem artificial especially to those who may consider market demand a true expression of physiological need. Market demand may be considered in basic terms an expression rather of demands that have been highly warped by misguided experience (or even by the lack of experience), by habit, and by the advertisers' over-emphasis upon eye-appeal and on other non-nutrient characteristics of food, until the original natural drives for food (hunger and appetite) and circumscribed experience result in a failure of the consuming group to

[16] Me. Agr. Exp. Sta. Bul. 400: 244, 1940.

[17] Me. Agr. Exp. Sta. Bul. 397: 733-737, 1939.

express the physiological imbalance or tensions which might otherwise under less artificial conditions be expressed in market demand. Experiments and experience indicate that even the severely undernourished may fail to express their physiological needs in terms of market demand.

Since measures of market demands, then, are quite inadequate as guides in food production and since the expressions of physiological needs in terms of food-getting appear to have been left largely to flounder for themselves, the distinction between the two kinds of foods—*market foods* and *foods for use* literally and actually appear to form the two horns of the dilemma. In this instance neither of the two measures of foods alone, or singly, can at present be expected to fulfill both functions or purposes for which foods are now produced. Some varieties of each food crop are produced for the market while other varieties of the same food crops appear to fulfill nutritional needs and may or may not be adaptable to the market.

It seems desirable to have a term with which to describe foods possessed of both nutritional and commodity acceptance value. They might be termed x to designate the fusion of two divergent types of foods. However, in order that the term be explicit for all of the uses (both physiological and bioeconomic) which have been and may be made of it, and in order that it express a measure both of individual (id) and group (aggregate) needs, the term *aggridant* has been conceived. Aggridant foods are defined as those which have been developed for the specific purpose of meeting needs. In dealing with physiological measurements, the term *aggridant* may be applied to those foods which produce so-called *aggridant* individuals, i.e., individuals characterized by a high rate of productive ability, long life, efficiency in the use of energy, and consistency in reaction.[18]

One might easily fall into the error of supposing that *aggridant* foods are synonymous with foods superior for their nutrient content, but this mistake must be avoided. The term *superior* implies, or is likely to imply, a *maximum*. A maximum of nutrient qualities in any one food, however, might lead to an over-balance of one nutrient as against another; we have pointed out, conversely, that the individual who grows at a maximum rate is not growing at an aggridant rate since the aggridant rate lies somewhat *below* the

[18] Me. Agr. Exp. Sta. Bul. 397: 739 and 745, 1939.

maximum of the group. This important observation is discussed in greater detail and is shown diagrammatically in a previous report.[19] The same asymmetry away from the maximum has been shown to exist in the pattern of different foods selected by aggridant individuals and in a pattern that mirrors regional needs.[20] In other words, one aspect of the term *aggridant* lies in *relatedness;* another aspect of the term is regionality. Superiority of a single food in and by itself may have little significance; in addition to quality in foods, the problem of food production is a problem of patterns of foods and the relation of these food patterns to regional consumer needs. A superior food, therefore, in and by itself, might even be harmful, if it should warp a pattern of foods adjusted to the needs of the individual consumer and of the consuming group.

In the pattern relationship between foods in the diet of the omnivorous human, an aggridant food exists only in its relatedness to all other foods: it is selected on the basis of its relatedness to all foods entering into the diet. The first steps in the selection of food crops for high nutritional value may therefore be erroneous if the characteristics of the pattern of individual foods, as well as of the group of foods, are not observed or if general values are sought ahead of specific values. In nutrition, nationalism is thereby approached through regionalism. The aggridant patterns of nutrients within each food and between different foods within each region and between different regions stand as advance guides of first degree approximation to mass food production and gene-nutrient selections, where heretofore no guides have existed except market demand and the subsidiary effects of nutritional education, which is only beginning to become aware of the distinction between market demand and nutritional needs.

The distinction between *aggridant* foods and *commodity* foods becomes especially clear when one attempts to improve either type of food. Some of the most important distinctions between aggridant foods and commodity foods are as follows:

(1) *Commodity foods* are measured by the effective demand in the market, a demand with serious limitations mentioned before. On the other hand, *aggridant* foods must not only have marketability

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[19] Me. Agr. Exp. Sta. Bul. 397: 752, 1939.

[20] Me. Agr. Exp. Sta. Bul. 397: 740, 1939, from data in *Amer. Nat.* 69: 487 (Table V), 1935.

but must measure up to at least four other standards summed up here from previous descriptions.

(2) *Aggridant* foods are designed to meet the nutritional needs of the region in which they are produced. This is their first purpose.[21] On the other hand, market foods may be shipped as commodities for exchange to distant regions where the nutritional needs are different or they may be destined for non-nutritional use in industry as corn oil, starch, glue, wax, alcohol.

(3) *Aggridant foods* meet the needs of a well-balanced agriculture by rounding out the food production program of the region in order to make physically possible a supply of the wide diversity of foods (species and varieties) which are required to assure an optimum accessibility to the nutrients most needed.[22] The nutrients needed most are disclosed in turn by the surveys on food production, on food habits, and on nutritional status of the inhabitants of the region when the production rates, the habits, and the status are compared with optimum standards. These surveys, in contrast to surveys for market demands, reflect the particular deficiencies, if any, in the regional diet and indicate additions or changes which should be made in the foods and patterns of foods for the region.

(4) *Aggridant foods* in turn may require new and appropriate methods for the assurance of their successful culture and for the retention of nutritional values frequently lost during the series of transactions of food commodities. These new methods include not only the development of an aggridant soil, but also of appropriate methods of production, distribution, storage, and preparation not heretofore of first concern in the production of commodity foods, and not always necessary in the production of foods destined for non-nutritional use.

(5) *Aggridant foods* are measured to meet not only individual need-values, like vitamins and minerals, but also to meet the group need-values of palatability and of general physiological demands.[23] Other characteristics of aggridant foods will be noted in their appropriate context. Some of the characteristics or measures of aggridant foods have been taken over profitably for the measure of commodity foods so that at present some of these may be equiva-

[21] Me. Agr. Exp. Sta. Bul. 400 : 245, 1940.

[22] Me. Agr. Exp. Sta. Bul. 397 : 742, 1939; *Amer. Nat.* 69 : 520, 1935.

[23] Me. Agr. Exp. Sta. Bul. 380 : 197, 1935, and *Amer. Nat.* 69 : 499-544, 1935.

lent to their counterpart in aggridant foods. But the point of view behind the demand for and the improvement of aggridant foods and behind the production methods for commodity foods is so different that these similarities probably exist largely through chance occurrence.

While we may attribute some of the malnutrition extant over the land to the over-concentration of attention upon the production of foods for the commodity market, on the other hand attention to nutritive value prior to or simultaneous with market value need not detract from the subsequent profit received; in fact, the gain in efficiency in the use of the foods of higher nutritive value should result in an increased over-all, long-time profit to the population provided the costs of malnutrition are included with the costs of production of commodity foods inappropriate nutritionally.

With this point of view as the directing principle for research on foods and food crops, whether the foods are to be used directly for human consumption or indirectly, through the animal, for human use, new experiments, some of which have been discussed in previous reports but are here brought up to date, have been designed as follows:

(1) To determine by means of surveys the incidence of deficiency diseases within the region, nutritional deficiencies which might be attributed to the lack of proper foods, as a means of determining regional lacks as well as regional normal needs. These values predetermine the nature of and the kinds of aggridant foods which should be developed.

(2) To secure, select, improve, and produce foods and food crops, regionally adaptable, and preserve the nutrient values desired to supply the needs as disclosed by the surveys of the region.

(3) To develop an aggridant soil.

In the following sections each one of these items will be considered briefly.

(b) *Regional Surveys of Needs as a Measure of the Nature of the Aggridant Foods to be Secured.* In a report for 1934[24] and in subsequent reports, the regional approach to the problem has been emphasized. Each region may have deficiencies peculiar only to itself as well as deficiencies similar to those in all regions. Physical examinations of populations, however, may be taken with different

[24] Me. Agr. Exp. Sta. Bul. 375: 191-284, 1934.

purposes in view: for army fitness (draft records), for public health purposes (school health records), for evaluating clothing requirements, and for nutritional status. For the purpose at hand, these physical examinations have pertinence to the problem of food-production only in so far as they may be interpreted to indicate general food lacks or specific food needs. *The nature and the severity or extent of the nutritional deficiencies discovered within the region suggest the nature of the aggridant foods to be developed.*

At the time of the first of these reports, the important nutritional deficiencies deduced from the physical records of conscripts in World War I were conceded to be related chiefly to lacks of calcium and vitamin D. Other deficiencies were noted, but these same defects of the bones, of the skeletal-muscular system, and of the teeth were confirmed by later detailed surveys reported in 1940.[25] In both reports anaemias were stressed as of second importance.

Also, from an analysis of the World War I draft records and from an analysis of food crop production per inhabitant, vitamin A and vitamin C deficiencies were predicted early in the 30's and plans were made for the genetic phase of the corrective program by the vitamin assays of Maine-grown varieties of fruits, vegetables, roots, and field crops.[26] However, only recently has evidence for the clinical or subclinical manifestations of these two nutritional deficiencies within the region been secured.

In the fall of 1940 in one large select group (college men and women) the frequency of retarded visual recovery time, which has been interpreted as evidence *en masse* of vitamin A deficiency, was found to be approximately 21 per cent.[27] In the spring of 1941 one small rural group showed a frequency of nearly 40 per cent retarded visual recovery time. In regard to vitamin C deficiencies, the recent observations[28, 29] show that 55 per cent of those tested had less than .40 mgms. of ascorbic acid per 100 cc. of blood.

Other deficiencies for which no survey data are as yet available, but for which corrective procedures have been kept in mind, include vitamins B, G, and E, together with the proteins, fats,

[25] Me. Agr. Exp. Sta. Bul. 401: 1-154, 1940 (Clayton).
[26] Report for the Me. Agr. Exp. Sta. Council, 1932.
[27] Me. Agr. Exp. Sta. Bul. 400: 241, 1940.
[28] N. E. Jour. Med. 224: 503-509, 1941 (Crane and Woods).
[29] Jour. Nutr. 21: 5: 527-539, 1941 (Murphy).

and carbohydrates. Nevertheless, the excess of underweight school children to overweight by a ratio of 13.5 to 1 and the frequency of underweight of 12.4 per cent of the school children of Maine in the years 1926 to 1934[30] may indicate a lack of some specific quality in the foods, a lack of a particular class of food, or the general lack of food as a whole.

As for mineral deficiencies in the soil and in the food crops produced therefrom, evidence is gradually being accumulated through an analysis of the soil tests of the Station soil testing laboratory and through actual cultivation of numerous varieties of the principal food crops on comparative fertile and infertile soils. This evidence suggests that calcium,[31] phosphorus, potassium, magnesium, and other minerals, and nitrogen are sometimes individually or together the limiting factor or factors in food production. Some of these limitations may not affect the production of *commodity foods* but may affect seriously the production of *aggridant foods*.

From this brief summary of surveys on nutritional status of the region, the special or individual (*id*) characteristics of the aggridant foods should obviously emphasize vitamins D, C, and A, and the mineral calcium. Such selections have already been described in previous reports and include fruits and vegetables as well as meat, dairy, and poultry products. New information on the results of these selections for aggridant food crops or for foods with aggridant potentialities are described in the following section.

(c) *Examples of Potential Aggridant Food Crops—to Meet the Needs of the Region.* During the search for potential aggridant foods it has been necessary to follow the assumption that nutritive value should precede, or at least accompany, market value. After the food has been developed, the values for nutrition and for the market fuse into one in terms of the aggridant type. As a consequence of this mode of approach many instances have been uncovered in which high nutritive value has been found in foods and crops not at present adaptable to market requirements. Some of these varieties had been relegated to the home garden for home use only. Other varieties have not even attained the distinction of domestication and are still known as wild forms. As a consequence of this experience in discovering wild forms of high nutri-

[30] Me. Agr. Exp. Sta. Bul. 397: 730, 1939.

[31] Me. Agr. Exp. Sta. Bul. 375, 1934.

tional value, a reversion has been made in some cases to primitive foods and food crops in order to retrieve, when lost, the genetic factors responsible for the high nutritive value of wild and of pioneer food crops. This reversion to wild or unselected strains of food crops shows that vitamin A may be retrieved, when lost, for the tomato, and for the potato, for buckwheat and possibly for wheat.[32] For these reasons some of the examples of potential aggridant foods described below represent first approximations toward the goal set. Some of the food crops would be of no value (as yet) for the market but as potential sources of genes which are being used for recombination with market foods they have high aggridant value. For example, Fort Kent Golden, a newly discovered green corn now used in a very limited northern area for home canning, is considered from the market viewpoint as of little or no value. Nevertheless, this variety possesses an exceptional genetic ability for earliness, for growth at low temperatures, combined with the carotinoids for vitamin A that make it exceedingly valuable as a potential source of aggridant maize in a region where vitamin A is not too abundant.

Buckwheat. Several varieties of buckwheat out of 14 varieties secured from various parts of the world in 1939 were nearly equal in vitamin A to a median grade of yellow corn.[33] The variety highest in vitamin A is now being selected for uniformity in adaptability to the region. The general lack of vitamin A food crops in the region, together with the fact that buckwheat has been and still remains a staple food in the northern part of the region, emphasizes the importance of this variety which is six times as potent in vitamin A as is the variety with the least vitamin A of those tested.

Thus, while buckwheat can be recognized as a superior vitamin A food crop, selections for special varieties may make it consistently superior.

Sweet Corn (Zea saccharata). White sweet corn varieties frequently mature early and yield heavily, and, as a consequence, are occasionally favored by the sweet corn canning industry. When yellow varieties are demanded by the consumer, yellowness is acquired. However, tests on these yellow varieties for vitamin

[32] Me. Agr. Exp. Sta. Bul. 400 : 244, 1940.
[33] Me. Agr. Exp. Sta. Bul. 400 : 244, 1940.

A show that the yellow color is not always a sign of high vitamin A content. As a result of the presence of yellow plant pigments, other than carotene or cryptoxanthine, several sweet corn varieties of industrial importance in the State appear to be very low in vitamin A.[38] As first approximations to desirable types, sweet corn varieties yellow in color and also high in vitamin A included the following: Sencross Hybrid, Golden Bantam, Golden Cross 2, Golden Cross Bantam, Golden Gem, Purgold Hybrid, Northern Cross Yellow, Seneca "60," and Early Yellow Sensation.

The vitamin A values for these adaptable varieties of sweet corn represent specific measures of their nutritional value. As stated previously, aggridant foods are measured not alone in terms of their specific individual nutrient values but also in more general terms as in tests of palatability. Tests on palatability of all varieties of sweet corn as well as of peas, cabbages, and clovers have been projected for the summer of 1941. Not until all such tests are completed will it be possible to recommend the truly aggridant varieties, i.e., those possessing adaptability to regional cultural requirements in addition to high special nutrient values plus high palatability and marketability. In the meantime, however, the varieties recommended under these tests are superior in some respects, if not in all respects, to most of the varieties now cultivated in the region.

Dent and Flint Corn (Zea indentata and Zea indurata). Dent and flint corn are used directly as human food in the form of meal. Either one or the other or both are used for Indian pudding, johnnycake, corn bread, hominy, corn grits, and, indirectly, through corn-fed animals, in the form of meat, milk, eggs, and cheese. A high vitamin A content of the corn varieties raised will therefore contribute to an improvement in the vitamin A nutritional status of both classes of consumer.

At the present day the production of dent and flint corn in northern New England has been replaced to a large extent by importations from the West. Several varieties are still grown: some of these are of white color (and therefore low in vitamin A), quick to mature, and of heavier yielding ability than some of the deep yellow varieties high in nutritional value but slower in rate of maturity. Such varieties as Aroostook White, Sweet Fodder, Dakota White Flint, and Minhybrid 402 are examples of white or

white and yellow varieties of field corn maturing early enough to produce large yields while Packard's White Sweet and Early White Aroostook are examples of White Sweet corn showing early maturity. Of the imported varieties, the Leaming strains have proved to be among the best in vitamin A.

In connection with this study, several locally adaptable strains of maize have now been tested. Two of these, Twitchell's Pride and a so-called "Fort Kent Golden," have possibilities as sources of genes for crosses and selections. These varieties are being grown in three parts of the State, Presque Isle, Orono, and Monmouth, in order that widely separated parts of the State may be represented. Comparisons are being made also with high vitamin A double cross hybrids in the corn breeding trial plots at Highmoor Farm.

Twitchell's Pride. Twitchell's Pride was one of the older varieties grown at Orono in 1940. The seed was secured from Mr. C. F. Bailey, Superintendent of the New Brunswick Agricultural Experiment Station, Fredericton. This variety had been grown for some time at the Canadian station and had, through selection and adaptation, become a valuable producer, having won first prize in the early flint class at the World's Grain Exhibition held in Regina, Sask., Canada, in 1933.[34]

For the first year in Orono, Maine, on clay soil, Twitchell's Pride was of the earliest and highest yielding of numerous local and imported varieties. The first year's success stimulated the seeding of six acres of this variety in the spring of 1941, while special methods for continual improvement were being practiced and while comparisons with other strains and crosses were being made. The variety, like many flint varieties, sometimes is not as erect as would be desired.

The original Twitchell's Pride was developed by Dr. George M. Twitchell, of Monmouth, Maine, as an adaptation to a short-season region, and the variety has a deep yellow color. Nevertheless, the strain must be planted by May 20th to ensure maturity in the vicinity of Latitude 45° North.

"Fort Kent Golden." This variety of green corn was discovered in the vicinity of Fort Kent, Maine, in the fall of 1940. It had

[34] This information was received from Mr. F. Dimmock, Department of Agriculture, Ottawa, Canada.

been planted after the first of June and was ripe and harvested by the first of September at a latitude of 47° 15′ North. The origin of the seed was not known, but its appearance and growth habits were similar to the *Mais quarantain* grown by the French in northern Maine over 100 years ago. This variety is being grown at Orono, Maine, with numerous old varieties of the region and with varieties of corn from the Indians of the Northwest and with short season varieties from Sweden and from Russia.[35]

Millet. Although millet has potential value as a source of vitamin A, some of the varieties recommended for large yields are low in nutritive value. On the other hand, the Golden or German Millet, the variety testing the highest for vitamin A in 1940, failed to mature seed at Orono (Lat. of 44° 54′ 2″ North). Consequently, reversion to the more heterozygotic Hungarian varieties has been made. Out of those varieties which are known to mature seed in the region, new strains high in nutritive value are being secured by breeding and selection.

Wheat. In comparison with the past, Maine today produces only a small part of the wheat required for flour and for feed. In contrast with past decades one can no longer purchase wheat on the market by variety or by grade. Furthermore, practically all of the wheat shipped into the State is labelled "wheat," and this term covers numerous sins of omission and of exchange; the term "wheat" covers several different grades and may be any one of soft, hard, spring or winter wheat, flour or durum wheat, and changes are made from one to the other without notice.

In addition to the lack of graded local wheat and to the dependence of the State on imported ungraded wheat, there exists no regional grain storage facilities. This throws the grain-getting problem into the lap of the transportation system on the one hand and into the hands of the processors of foods on the other hand. Even in face of the huge national grain storages, either one of these dependencies fails to meet regional nutritional problems.

The lack of access to specific grades of wheat within the

[35] In the summer of 1941 in comparison with all of these varieties, the Fort Kent Golden has proven to be 10 to 12 days ahead of all other varieties of both sweet and field corn to the date of silking and dehiscing of the pollen. As a potential source of vitamin A for all parts of the State this variety has exceptional possibilities. The variety had ripe hard ears by the 26th of August.

region is, therefore, an economic problem of distribution related nevertheless directly to malnutrition, since the necessity for whole grain flour of known origin and quality for optimum nutrition is blocked at its very beginnings. The cost of the imported nutritious whole wheat flour is two to three times the price of the refined white flour.[36] Experiments carried on in this laboratory on food choice show that the native instinctive choice of experimental animals for the natural unrefined foods is a positive nutritional factor with these animals.[37, 38]

Wheat Varieties and Nutrition. The recently organized National Nutrition Committee for Defense has officially recognized the necessity for a return to whole wheat flour—accepting temporarily the expedient of "reinforced" refined flour. The nutrition studies and food selection experiments carried on in this department have been for many years on the basis of whole ground grains.

Substantiation in the merit of this conclusion to return to whole grains as the basis for food-getting plans is also secured in the recent experiments on various kinds of bread in which peeled wheat bread, i.e., whole wheat deprived merely of its thin horny epidermis by the Earle flotation process, had 4.3 per cent higher protein efficiency than white bread, together with the additional values over white bread of minerals and vitamins.[39]

Our experiments on wheat include this factor of wholeness as advantageous for the prevention of malnutrition and go a step farther to include the desire to regain those characteristics of the wheat berry lost through the process of domestication of wheat, as also necessary for proper readjustment of the inhabitants to the environment.

Since these revived or new varieties of wheat are selections based upon an attempt to return to the original wheat berry prior to their subjection to selection for whiteness, one would expect them to produce bread superior even to the peeled white wheat bread. Wheat varieties, according to the tests reported last year,[40]

[36] Me. Agr. Exp. Sta. Bul. 397: 767, 1939.

[37] *Amer. Nat.* 69: 469-544, 1935.

[38] *Jour. Hered.* 30: 161, 1939.

[39] National Nutritional Conference in Washington. (Science 94: Suppl. p. 10, 25 July 1941.)

[40] Me. Agr. Exp. Sta. Bul. 400: 244, 1940.

are relatively quite variable in their vitamin A content and are low in comparison to a food crop like buckwheat which has not been selected for whiteness. In wheat as with other food crops, it was found necessary to revert to older varieties and to varieties previously discontinued in the recommendations of Wheat Improvement Planning Boards when the discontinuance was based upon the mere presence of a yellow color. Although the yellow color of the wheat starch may not always be caused by the presence of precursors of vitamin A, nevertheless the chances for such an association are worth consideration as a preliminary guide in the search for valuable varieties.

Production trials on six of these varieties of potential aggridant value, grown at Presque Isle in the summer of 1940, gave the following calculated yields per acre:[41]

	Bushels per acre	Straw lbs. per acre	Per cent straw
Minn. No. 2682	32.5	2711	58.2
McMurachy's Selection	29.9	2996	62.6
Marquillo	29.5	3098	63.7
Amber Durum	26.9	2726	62.8
Golden Ball Durum	26.1	2330	59.8
Pelissier	20.3	2933	70.7

Several of the foregoing varieties were among the highest producers of grain in the season of 1940.

One to two acre plantings of each of half a dozen potentially valuable varieties were harvested in 1940 and will again be harvested in 1941. From these harvests seed should be available for general distribution for the spring planting season of 1942.

Encouragement of Cereal Grain Production by Means of the Combine Harvester and the Hammer Mill. Since the so-called aggridant type of individual depends upon an agricultural system which supplies a wide diversity of foods as well as the right quality of foods, the extension of, or return of, cereal grain culture to northern New England is a move in the right direction. However, in order to ensure this return, several obstacles responsible possibly in part for the decline of cereal grain culture must first be met or

[41] These records were secured by Mr. Arthur Hawkins in connection with the Wheat Variety Trials.

must be eliminated. The first of these obstacles is the frequency of rain and wet weather at harvest time while the second obstacle is encountered when wet weather delays the harvest of cereals to a time when the potato harvest starts. The suggestion is made that both of these impediments may be avoided by the use of a combine harvester. Some of these machines are already in use within the region; but here we emphasize merely their potential relationship to nutrition in view of the continued loss of grain in the field and in the shock and in view of a potential stimulus to more cereal culture. Such a grain combine (cutter and thresher) was purchased for use at Aroostook Farm in the summer of 1940. By means of this machine, two men are able to bring in a harvest of bagged grain from the field without the weather hazard and time-loss and interference associated with shocking, stacking, and threshing when each operation is separate. As an inducement to the extension of cereal grain production in the region and consequently as a means of precluding one form of malnutrition, the grain combine may be of some importance.

Another mechanical encouragement for cereal-grain culture would be the installation of hammer mills distributed locally. The relation of this type of mill to nutrition has been discussed in a previous report.[42]

(d) *An Aggridant Soil.* The production of aggridant food crops implies a soil treatment or cultural practice to make possible the production of both an optimum nutrient quality in the food crop and a desirable pattern of foods.

In order to produce aggridant foods there are two factors in soil science which are of particular importance over and above other factors which are conceded as more important for the production of market food crops. The first of these soil charactristics which become important in the production of aggridant food crops is the relation of the mineral in the soil to the mineral content of the foods produced. This characteristic has been the subject of much past and recent discussion. But in spite of much work on the subject from the chemical analytical approach, there still remains much to be learned on the relative physiological merit of crops produced on soils differing in a range of fertility levels. Such experiments are in progress. From these experiments with foods raised

[42] Me. Agr. Exp. Sta. Bul. 397: 769, 1939.

on a soil varying from low to very high in fertility, the correct level of fertility may be discovered which will support the aggridant food crops at an optimum.

The second soil characteristic which becomes important for the production of aggridant food crops is that level and balance necessary for the growth and maturity not of single market food crops but of the desired pattern of foods. Complete diversification in this respect for all soils is not thereby implied—but rather a partial diversification (called the specialization-diversification pattern[43]) of adjustment to several food crops rather than to one alone. This fact becomes especially significant in the production of some of the cereal grains, such as wheat, which apparently thrives better on a soil higher in calcium than on a soil required for successful potato production.

It has been stated before that aggridant food crops have their individual values in terms of vitamin, protein, fat or mineral, as well as general appetitive values in terms of palatability and general physiological measurements. In the same manner whereby the characteristics of aggridant foods may be distinguished by their special (*id*) values as well as by their general group (aggregate) values so too may the aggridant soils be described and treated experimentally. The experiments in progress at the Orono field laboratory with numerous food crops (by species and by variety) on fertile versus infertile soil deal chiefly with the *id* characteristics of an aggridant soil.

The information secured from these experiments is now being analyzed. The results show striking differences between both species and varieties in their ability to develop and come to maturity on poor soil. Important differences are shown also in the ability of some species to secure a higher concentration of some of the minerals on poor soil than on rich soil. These are important distinctions in the production of aggridant food crops and will aid in the detection of the most suitable varieties for the region.

The group characteristics of an aggridant soil obviously have two aspects, one, the relative difference between soil types as potential producers of food, and the other, the ability of any particular soil plot (or farm) to produce the desired pattern of foods. In order to extend the research on this latter aspect of aggridant soils a plan

[43] Me. Agr. Exp. Sta. Bul. 397: 738 and 743, 1939.

was adopted in August 1940 to test the soils of each farm—not on the usual basis for a market specialty crop only, but (1) in terms of the farm-as-a-whole, (2) in terms of an entire rotation, and (3) in terms of a correct ratio between specialization and diversification. These tests are only of secondary importance in the cultivation of commodity food crops, but are of primary importance in the production of aggridant food crops. As an example this procedure was adapted to a study carried on in connection with a cooperative project with the Farm Security Administration National Health Survey and has been used since that date in an analysis of records on soil fertility secured by the Station soil testing laboratory.

The results from this study suggest the possibility that (a) the special crop received an undue proportion of the attention in terms of commercial fertilizer, that (b) this attention is frequently in excess of requirements for efficient utilization, and that (c) only by means of an entire farm soil-crop survey will research information be made fully available for a wise adjustment of rotation practices and for an analysis of the relation of soil fertility to human nutrition.

Many aspects of the soil, of the crops, and of the consumer, in terms of the aggridant type, remain to be presented from the results of experiments now in progress. So far, the aggridant food, as the element in between the soil and the consumer, must be produced by a reversion to the past to regain nutritional advantages lost in the process of domestication for commodity purposes and by a fusion of these retrieved nutritional values with the best of present varieties. These aggridant varieties as the product of individual (*id*) and group (aggregate) measurements must be synchronized with the individual and with the group characteristics of the soil on the one hand and of the consumer on the other hand. In this fusion of divergencies there arises a creative synthesis that indicates the direction for one form of progress.

FORAGE CROPS

ALFALFA STRAIN TRIALS. Russell M. Bailey and Delmar S. Fink. A study of alfalfa strains is in progress in order to determine those best adapted to Maine. Several of the Michigan selections appear somewhat superior to Grimm, but the results are in-

conclusive as yet. Grimm has done well and is recommended to farmers for trial.

GRASSLAND STUDIES. Delmar S. Fink and Paul Mosher. Table 8 shows the yield in pounds of milk per acre obtained from five permanent pasture paddocks at Highmoor Farm. The paddocks were originally a part of an old "run-out" permanent pasture of which paddock 8, having been left untreated, still remains typical.

TABLE 8

The Yield in Pounds Milk Per Acre for Five Permanent Pasture Paddocks at Highmoor Farm

Treatment[1]	Yield in Pounds Milk for				
	1936	1937	1938	1939	1940
Paddock 6—Minerals only	1400	1850	3025	2500	3425
Paddock 7—Complete, commercial	2600	2625	3825	3455	4250
Paddock 8—No treatment	700	675	925	758	1025
Paddock 9—Manure, top-dressed	1500	1800	3325	3378	4950
Paddock 10—Manure, plowed and seeded	3000	3375	4225	3875	plowed

[1] For treatment in detail see Me. Agr. Exp. Sta. Bul. 397, p. 774, 1939.
Note: Milk yields are on a standard cow basis, or a 1,000 pound cow giving 25 pounds of 4 per cent milk and obtaining all feed from paddock stated.

The fertilized paddocks, under five years of treatment, have developed into excellent pastures, as indicated by yield figures, appearance of turf, analysis of vegetation (see Table 9), and improvement in level of soil fertility. At the close of the 1940 season each of the fertilized paddocks was divided in half. One half of each completely fertilized paddock is to receive annually 100 pounds each of N, P_2O_5, and K_2O per acre, and the other half 50 pounds each of N, P_2O_5, and K_2O per acre. One half of paddock 6 will receive, annually, 100 pounds each of P_2O_5 and K_2O per acre, and the other half 50 pounds each of P_2O_5 and K_2O per acre. The object of this study is to get information as to the plant food required to maintain an excellent pasture in excellent production.

Ladino clover-timothy association has become the sole source

of hay and silage for winter feed, and of pasture for the milking herd from July to November, at Highmoor Farm. Seeding trials, reported in 1939 (Me. Agr. Exp. Sta. Bul. 397) showed that two pounds of ladino clover and seven pounds of timothy per acre produced an excellent stand for pasture, hay, or silage. These conclusions are supported by the results of the past year. In paddock 4 at Highmoor Farm, which was a part of an old "run-out" permanent pasture, ladino clover has become well established through merely broadcasting ladino clover seed and mineral fertilizers on top of the sod.

Observations indicate that a grass superior to timothy in rapidity of growth is needed in association with ladino clover, and to this end a "grass species ladino clover" trial is under way at Highmoor Farm.

GRASS SILAGE INVESTIGATIONS. Delmar S. Fink and Bernie E. Plummer, Jr. Grass silage investigations, dealing with ladino clover-timothy association as a source of material, were started

TABLE 9

The Yield per Acre and Analysis of Composite Samples of Clippings Taken During 1940 from Pasture Paddocks

Treatment[1]	Paddock 6 Minerals only	Paddock 7 Complete, commercial	Paddock 8 No treatment	Paddock 9 Manure, top-dressed
Times harvested	5	5	3	6
Yield, dry matter per acre, lbs.	3,942	4,225	1,220	4,857
Vegetation (estimated)	70% white clover 20% grass 10% weeds	30% white clover 70% grass	80% grass 15% weeds 5% bare ground	50% white clover 50% grass
Analysis (dry basis)	%	%	%	%
Dry matter	18.70	20.59	30.86	20.87
Nitrogen	3.74	3.35	1.94	3.39
Protein	23.35	20.94	12.12	21.19
Fat	3.00	3.48	3.36	2.95
Fiber	20.63	21.86	23.44	21.30
Ash	8.98	7.54	6.75	8.17
Insoluble ash	1.52	1.28	2.77	1.75
Phosphorus	0.41	0.36	0.14	0.38
Calcium	0.99	0.69	0.56	0.72
Magnesium	0.29	0.27	0.21	0.31
Potassium	2.72	2.30	1.46	2.65

[1] See Maine Agr. Exp. Sta. Bul. 397, p. 774, 1939, for Treatment in detail of Paddocks.

Note: A total of twenty areas, one square foot each, were harvested by clipping immediately prior to turning the cows into a paddock. Areas clipped were selected at random except that feces and urine spots and any previously ungrazed vegetation were avoided. Paddocks were first grazed by the milking herd at a rate of 18 cows per acre, followed immediately by dry stock at nine heifers (bred) per acre. Clippings were oven dried and season composite sample made on the basis of dry matter yield of clippings. Chemical analyses were made by B. E. Plummer, Jr., Department of Chemistry, Maine Agricultural Experiment Station.

during the 1940-1941 season. The main objective in this study was to determine the losses sustained in total weight and dry matter by ladino clover-timothy association when made into silage under two different methods of preserving grass for silage.

It is common experience to observe a tremendous amount of seepage from silos filled with material cut into the silo directly from the field. Acccording to other workers[44] drainage may cause appreciable losses in dry matter, nitrogen, and minerals. In addition this effluent creates very undesirable odors on the average farm because means have not been made available for its disposal. It appears advisable, both from the standpoint of the conservation of feeding constituents as well as freedom from undesirable odors, to put up grass silage in such a manner that seepage will be held down to a minimum. Other workers[44] have shown that seepage can be eliminated with many grass crops through partial air-drying of the material prior to cutting into the silo, and at the same time excellent silage can be produced.

The study reported here comprises a comparison of:

Silo 1.—First crop ladino clover-timothy association cut in directly from the field with fifty pounds of molasses added per ton of fresh material.

Silo 2.—Second crop ladino clover-timothy association cut in partially air-dried with five gallons of dilute phosphoric acid (one gallon of 75 per cent food-grade phosphoric acid to four gallons of water) added per ton of partially air-dry material.

The losses sustained in total weight for the two methods of preservation were (see Table 10) 32.4 per cent for silo 1 and 5.5 per cent for silo 2. The losses in total dry matter were 19.4 per cent in the case of silo 1, and 7.3 per cent in the case of silo 2 (see Table 10).

The total pounds loss in dry matter for silo 1, or 4,833 pounds, accounts for but 13.1 per cent of the 36,906 pounds loss in total weight. The remainder, or 86.9 per cent of the loss in total weight, is due to loss in moisture. From these percentage figures it would appear that the large losses in total weight sustained by material cut into the silo directly from the field are mostly moisture and of little concern. Actually, however, the pounds loss in

[44] The Science and Practice of Conservation: Grass and Forage Crops. S J. Watson, Vol. 1, pp. 311-374. 1939.

dry matter for silo 1, or 4,832.9 pounds, is large and will be observed to be far in excess of that sustained in silo 2.

The total pounds loss in dry matter for silo 2, or 1,525 pounds, accounts for 43.3 per cent of the 3,522 pounds loss in total weight. The remainder, or 56.7 per cent of loss in total weight, is due to loss in moisture. The losses in both total weight and dry matter from silo 2 may be considered unavoidable losses since there was no seepage from this silo.

The silage from both silo 1 and 2 was of high quality, free from butyric acid, and of good color. Except for the immediate surface, both silages maintained a consistent pH value of 4.0 ± 0.1 throughout.

In view of the marked conservation of feeding constituents, as indicated by the reduced losses in dry matter, it appears advisable to partially air-dry ladino clover-timothy prior to cutting into the silo.

TABLE 10

The Percentage Losses in Total Weight, Spoilage, and Dry Matter for Two Different Methods of Silage Preservation, Together with the Pounds of Each Silage to Give One Pound of Dry Matter

Ladino Clover-Timothy was the Source of Silage Material

	Silo 1 (22% dry matter with molasses)	Silo 2 (33% dry matter with H_3PO_4)
Total pounds of material, including preservative, weighed in	113,924	63,559
Total pounds of silage, including spoilage, weighed out	77,018	60,037
Pounds loss in total weight of material put in	36,906	3,522
Percentage loss in total weight of material put in	32.4	5.5
Total pounds spoiled silage	2,436	1,280
Percentage loss of material due to spoilage	2.1	2.0
[1] Per cent dry matter content, including preservative, of material in	21.86	33.1
Total pounds dry matter in	24,903.8	21,037.0
[1] Per cent dry matter content of silage out	26.06	32.5
Total pounds of dry matter out	20,070.9	19,512.0
Pounds loss in total dry matter put in	4,832.9	1,525.0
Percentage loss in total dry matter put in	19.4	7.3
Cubic feet occupied by silage at start of feeding	1,577	1,894
Average weight per cubic foot, pounds	48.8	43.1
Pounds silage to give one pound of dry matter	3.84	3.08

[1] Dry matter determinations of material in and silage out were made on composite samples of same material. During filling three bags full of the silage were buried following approximately every three tons of fresh material (silo 1) and every ton and half of air-dry material (silo 2). Dry matter determinations for a given level in each silo were weighted according to silage represented by each bag. A total of 54 bags were buried in silo 1 and 60 bags in silo 2.

INSPECTION SERVICE

INSPECTION SERVICE. Elmer R. Tobey, C. Harry White, Bernie E. Plummer, Jr., Glenn H. Perkins, Millard G. Moore, Edward O. Merrill, C. Byron Sibley, John S. Getchell, and George P. Steinbauer. The Commissioner of Agriculture is the executive of the laws regulating the sale of fertilizers, agricultural seeds, insecticides, fungicides, foods, drugs, and feeding stuffs in Maine. It is the duty of the Director of the Maine Agricultural Experiment Station to analyze or cause to be analyzed the samples collected by the Commissioner and to publish the results of the analyses together with the names of the persons from whom the samples were obtained and such additional information as may seem advisable. This information is reported in the Official Inspections published during the year. The State Tax Assessor is the executive of the laws regulating the sale of gasoline and motor lubricants. It is the duty of the Director of the Station to analyze or cause to be analyzed the samples collected by the State Tax Assessor but no provision has been made for the publication of the results of the analyses.

In addition to the inspection service, the department is requested frequently to make analyses of various types of materials for individuals. These unofficial samples include milk, cream, vinegar, miscellaneous substances, and materials suspected to contain poison. The results of the analyses on these samples are not published but are reported to the individuals who submit the samples.

A brief summary of the work of inspection is as follows:

Testing of Dairy Glassware. It is required by law that all Babcock glassware used in Maine by creameries, ice cream factories, or others buying or selling milk or cream on a basis of the butterfat content must be tested for accuracy at the Maine Agricultural Experiment Station. One thousand sixteen pieces were examined and all were passed.

Fertilizer Inspection. Four hundred eight samples of fertilizer materials were collected and analyzed. Three hundred six of these samples were mixed fertilizers containing nitrogen, phosphoric acid, potash, and, in some of the samples, magnesium. One sample was guaranteed to contain borax. The samples of mixed fertilizers

represented two hundred sixty different brands. The results of the analyses are reported in Official Inspections 177.

Agricultural Seeds. Fungicides and Insecticides Inspection. One hundred sixty-two official samples of seeds and forty-four samples of fungicides and insecticides were collected and analyzed. The results of the analyses are reported in Official Inspections 178.

Food and Drug Inspection. The number and variety of samples collected and submitted depend upon the nature of the inspection work carried on by the Division of Inspection, Augusta, Maine, in the enforcement of the food and drug laws. A total number of five hundred eighty-five samples were submitted consisting of beverages containing caffeine and theobromine, butter, carbonated beverages, dog food, hamburg, jellies, oil used in packing sardines, sardines, shellfish, cold capsules, diluted hydrochloric acid, headache remedies, solution of hydrogen peroxide, solution of magnesium citrate, spirit of camphor, spirit of peppermint, and sweet spirit of nitre. These have been examined, and the results of the analyses are reported in Official Inspections 179.

Bacteriological Work. The amount of work carried on in the bacteriological laboratory has increased approximately one thousand five hundred samples over last year. A total of five thousand seven hundred fifty-nine samples have been examined. Of this number, four thousand two hundred thirty-seven samples were milk and cream, five hundred forty-nine were examinations of drinking utensils; the remaining number includes three hundred sixty-three samples of sea water and one hundred seventy-seven samples of shellfish. Fifty-three samples of potato starch have been examined. In addition, about three hundred eighty miscellaneous samples have been examined for municipal departments of health and private individuals. The results of the analyses are reported in the food and drug Official Inspections 179.

Feeding Stuffs Inspection. Eight hundred nine samples of feeding stuffs were received and the percentages of protein, fat, and fiber in these samples were determined. The results of the analyses will be published in Official Inspections 180.

Gasoline Inspection. Two hundred sixty-three samples of gasoline were received. The results of the analyses indicate that two of these samples were found to require a higher temperature

for complete distillation than the maximum temperature (437° F.) specified in the Maine law regulating the sale of motor gasoline.

Motor Lubricants Inspection. Ten of the thirty-eight samples of motor oils which were examined failed to meet the specifications for the respective brands asked for by the inspector. In nearly every instance it appeared to be a case of substitution by the salesman.

LAND UTILIZATION

Land Use Studies—Soil Survey. Joseph A. Chucka, Delmar B. Lovejoy, and John R. Arno in cooperation with Kenneth V. Goodman of the Soil Survey Division, Bureau of Plant Industry, and S. Von Day of the Soil Conservation Service, United States Department of Agriculture. The soil classification and mapping was continued during the past year as part of the Land Use Studies. The field work for a soil survey of Waldo County was completed in November, 1940. In the spring of 1941 field work was begun in Penobscot County.

Soil Testing Service. Delmar S. Fink and J. Wilfred Cyr. During the past year several thousand soil samples were analyzed for Maine farmers. Soil and crop improvement recommendations, on the basis of soil test information, are being handled through the office of Mr. Oscar Wyman of the Extension Service. A number of special studies are under way in the laboratory at all times. A report of two of these studies follows:

The pH and Available Calcium Relationships within Fields Producing Both Scabby and Clean Potatoes. Mr. V. C. Beverly and Mr. Bryce Jordan, Aroostook County Agent and Assistant respectively, secured soil samples from thirty-four widely separated potato fields in which potato scab was prevalent. One location in each field was sampled where the potatoes were definitely scabby. A second location was sampled in the same field where the potatoes were definitely free of scab. Every attempt was made to keep the two locations sampled as nearly adjacent as possible. The active soil acidity (pH) and the available calcium relationships are shown in Table 11.

All but eight of the thirty-four areas producing scabby potatoes are naturally very high in available calcium, as indicated by

subsoil analysis, and would be expected to produce scabby potatoes. Scab was apparently present on two areas, numbers 20 and 33, which cannot be accounted for on the basis of available calcium content of the soil. Likewise, there is little reason to expect scab on areas numbered 8 and 25 in view of the pH value of the soil. One area producing scabby potatoes, number 30, is handy to where an old lime kiln was in operation and scab is no doubt a result of overliming in this case. Scab on three areas, numbers 1, 13, and 27, definitely appears to be due to overliming sometime in the past.

Five of the areas (Numbers 9, 11, 29, 31, and 34) producing clean potatoes would be expected to produce scabby potatoes on the basis of available calcium content of both surface soil and subsoil. However, only one of these areas, number 29, shows a pH value appreciably above 5.5, or above the lower limit ordinarily set for the appearance of scab.

The conclusions which may be derived from this work have been common knowledge for quite some time. A correlation is noticeable between pH and available calcium, and between both these soil factors and the presence or absence of scab when comparing absolutely scabby vs. definitely nonscabby areas. However, from this work no information is gained as to the crucial pH value and available calcium content of the soil at which scab becomes prevalent. This study should be further enlarged to obtain this information.

A brief perusal of pH figures in Table 11 shows that a pH value alone cannot be relied upon to give accurate liming recommendations for potato soils. This is further clearly illustrated in the following study.

The Available Calcium and pH Relationships in Aroostook County Potato Soils. Aroostook County potato soils at various levels of available calcium show the following pH values:

Pounds available calcium per acre	250 – pH 5.09
Pounds available calcium per acre	500 – pH 5.11
Pounds available calcium per acre	750 – pH 5.11
Pounds available calcium per acre	1,000 – pH 5.17
Pounds available calcium per acre	1,500 – pH 5.19
Pounds available calcium per acre	2,000 – pH 5.28
Pounds available calcium per acre	3,000 – pH 5.65
Pounds available calcium per acre	4,000 – pH 6.21

These data (see Table 12 for further details) are a summary of 3,541 soil samples, tested by the Soil Testing Service. The pH determinations were made by the glass electrode method which gives pH measurements accurate to ±0.05 of a pH unit.

Obviously the differences in mean pH value for variations in available calcium content from 250 to 1,500 pounds per acre are too small to be significant. The differences between the mean pH values for the higher levels of available calcium (2,000 to 4,000 pounds per acre inclusive) are highly significant—when a large number of samples are considerd.

However, the problem faced in soil testing work is whether the pH value of a single sample can be used to give an accurate indication of the available calcium content of that particular soil. Column 5, Table 12, shows the range in pH value within which approximately two-thirds of all samples fall for a given level of available calcium. It should be further stated that one-sixth of the samples for each level of available calcium fall above and one-sixth below the range in pH value indicated. From the range in pH values shown it is concluded that pH determination of a single soil sample gives little or no information as to its content of available calcium, especially below about 2,000 pounds of available calcium per acre.

For example, the group with a mean available calcium content of 500 pounds per acre had a mean pH value of 5.11 with a standard deviation of 0.22. This indicates that about two-thirds of the samples in this group had a pH value of 4.89 to 5.33; and about one-sixth of the samples had a pH value that was actually above 5.33.

In the group with a mean available calcium content of 2,000 pounds per acre, the mean pH value was 5.28 with a standard deviation of 0.35. This indicates that about two-thirds of the samples in this group had a pH value of 4.93 to 5.63, and that one-sixth actually had a pH value lower than 4.93.

From these observations it is clear that a pH determination of a single soil sample is of no value in indicating the calcium content of the soil inasmuch as one-sixth of the soil samples with a low calcium content were above pH 5.33 and one-sixth of the soil samples with a higher calcium content were below pH 4.93.

There are several soil factors which tend to break down an

expected correlation between the available calcium content of the soil and its pH value. The almost complete lack of such a correlation in Aroostook County soils is in all probability due largely to the addition of large amounts of calcium sulphate (gypsum) carried in the liberal applications of complete fertilizers used. Gypsum has no appreciable effect on the pH value of the soil.

Other studies have shown that good yielding potato soils carry at least 1,500 pounds of available calcium per acre. Soils carrying 750 pounds of available calcium or less give low yields of potatoes and are badly in need of liming. There is every reason to believe that the 3,541 soil samples represented in Table 12 give a fair cross

TABLE 11

The pH and Available Calcium Relationships within Fields Producing Both Scabby and Clean Potatoes

Field No.	Scabby potatoes				Clean potatoes			
	Surface soil		Subsoil		Surface soil		Subsoil	
	pH	Ca	pH	Ca	pH	Ca	pH	Ca
1	5.71	Ex.	5.40	500	5.00	1000	5.55	500
2	5.75	Ex.	6.59	Ex.	4.79	1000	5.35	500
3	5.99	4000	6.36	Ex.	5.11	750	5.13	750
4	7.20	Ex.	6.10	Ex.	4.78	1000	4.99	750
5	6.58	Ex.	6.78	Ex.	5.01	1000	5.38	500
6	5.62	4000	6.28	3000	5.01	3000	5.57	1000
7	5.59	Ex.	6.29	3000	4.70	1000	5.45	750
8	5.20	3000	4.70	1000	4.99	1000	4.93	750
9	5.60	Ex.	6.32	4000	5.11	Ex.	5.70	3000
10	7.49	Ex.	6.89	2000	5.10	1000	5.22	500
11	6.79	Ex.	7.11	4000	5.33	4000	5.91	2000
12	6.42	Ex.	7.08	Ex.	4.67	2000	5.35	1000
13	5.95	4000	5.90	500	4.81	1000	5.25	750
14	6.19	Ex.	6.77	Ex.	4.81	500	4.94	500
15	6.00	Ex.	6.30	Ex.	4.54	1000	4.98	500
16	5.95	Ex.	6.46	3000	4.80	1000	5.29	500
17	6.10	Ex.	5.50	2000	5.00	750	5.26	500
18	6.06	Ex.	6.40	Ex.	5.35	3000	5.52	1000
19	6.15	Ex.	6.61	Ex.	4.78	2000	5.80	1000
20	4.78	1000	4.80	500	4.90	1000	4.80	500
21	5.83	3000	6.09	2000	4.35	500	4.72	500
22	6.20	Ex.	6.43	4000	4.91	1000	5.20	500
23	7.20	Ex.	6.00	3000	5.20	1000	5.25	1000
24	6.08	Ex.	6.69	3000	4.71	2000	5.34	500
25	5.25	3000	5.86	1000	4.71	1000	5.11	500
26	6.42	Ex.	6.82	Ex.	4.61	750	5.19	500
27	6.31	3000	5.58	750	5.07	1000	5.49	500
28	6.42	Ex.	6.31	Ex.	5.41	1000	5.44	500
29	6.01	Ex.	6.60	3000	5.60	3000	6.30	2000
30	5.65	3000	5.90	500	4.93	750	5.39	500
31	6.50	Ex.	7.09	Ex.	4.85	3000	5.49	2000
32	5.43	3000	6.38	4000	No	sample	6.13	3000
33	5.22	1000	5.07	500	No	sample	No	sample
34	5.69	Ex.	5.84	4000	5.28	4000	5.90	3000
Average	6.04	4324	6.21	3213	4.94	1594	5.37	977

Note: Excess Ca = 5,000 pounds or over but 5,000 pounds used in arriving at averages.

section of the potato soils in Aroostook County. This being true, the data indicate that 40 per cent of the potato soils in Aroostook County have less than 1,000 pounds of available calcium per acre and are badly in need of liming. An additional one-third of the area needs regular calcium additions to maintain the apparent adequate supply present. Calcium maintenance is probably no problem on about one-fourth of the land growing potatoes.

TABLE 12

The Available Calcium and pH Relationships in Aroostook County Potato Soils. Together with Some General Comments

Pounds available calcium per acre	Mean pH	Standard error of mean	Standard deviation in pH value	pH range within which two-thirds of samples fall	Number of samples	Per cent of total number of samples	General comments
250	5.09	0.013	0.20	4.89 – 5.29	249	7.03	40.18 per cent badly in need of liming
500	5.11	0.009	0.22	4.89 – 5.33	532	15.02	
750	5.11	0.013	0.33	4.78 – 5.44	642	18.13	
1000	5.17	0.007	0.24	4.93 – 5.41	944	26.66	33.10 per cent need regular applications of calcium for maintenance
1500	5.19	0.016	0.24	4.95 – 5.43	228	6.44	
2000	5.28	0.018	0.35	4.93 – 5.63	392	11.07	26.71 per cent need no immediate applications of calcium or may never need calcium additions
3000	5.65	0.022	0.42	5.23 – 6.07	363	10.25	
4000	6.21	0.039	0.54	5.67 – 6.75	191	5.39	

LAND USE STUDIES IN MAINE. Andrew E. Watson. A land classification study was conducted in twenty-five Waldo County towns during the summer of 1940. The field data gathered in connection with this study have been summarized. In this study the land was placed in six classifications, depending upon present physical and economic attributes as well as future capabilities and adaptations.

Supplemental data, which also will be used, have been made available by the Federal Bureau of Agricultural Economics and the Maine Extension Service. The Bureau of Agricultural Economics has made a detailed study of local governmental costs and State aids in two towns of the County. The general situation in these two towns is comparable with that to be found in many of the other towns. The Extension Service study has furnished considerable material dealing largely with social conditions in the various land classes. Additional information was secured from detailed farm records taken in the County in 1933 in connection with a dairy study.

POTATOES

AN ECONOMIC STUDY OF THE POTATO INDUSTRY IN MAINE. William E. Schrumpf. *Farm Organization and Costs and Returns in Producing Potatoes in Central Maine, 1938.* The basis for this work is 146 survey records of central Maine farms on which potatoes were an important farm enterprise. Of these farms 79 having potatoes as the chief source of income and 48 per cent or more of the total farm receipts from potatoes were classed as potato farms. Thirty-six farms having livestock products (mostly dairy products) as the chief source of income and 48 per cent or more of the total farm receipts from livestock were classed as livestock farms. Thirty-one farms not having 48 per cent of the total farm receipts from any single enterprise were classed as general farms.

The physical and financial setups of the farms in the three groups are compared to show reasons for differences in costs and returns from the potato enterprise and from the farm business as a whole and to indicate the factors which make for successful farming. Some of the factors considered are the various farm enterprises, the yield rates, the capital investment, tractive power, labor, and equipment.

MARKETING MAINE POTATOES. Charles H. Merchant, Maynard A. Hincks, Gordon W. Sprague, Gertrude G. Foelsch, Herbert W. Mumford, Jr., and Raymond L. Spangler. The cooperative study between the Cooperative Research and Service Division of the Farm Credit Administration and the Department of Agricultural Economics of the Maine Agricultural Experiment Station which began January 1, 1940, was continued during the past year. During March and April of 1940, information was obtained in Metropolitan Boston on (1) consumer purchases for potatoes, (2) retail store practices in selling potatoes, and (3) a study of practices in the wholesale marketing of potatoes. Of the five preliminary reports prepared, four were released during the past fiscal year. These reports are as follows:

1. Retail Distribution of Potatoes in the Boston Metropolitan Area, March 1940.
2. Purchase and Use of Potatoes and Substitutes in Homes of Boston Consumers, March 4 to April 6, 1940.
3. Organization and Market Practices in Maine and Boston.

4. Boston Retail Prices as Associated with Types of Packages, Retailers, and Consumer Incomes, February 26 to April 6, 1940.

The Maine Agricultural Experiment Station has made available a preliminary report on "Interregional Competition of Maine Potatoes in the Boston Market" (Misc. Publ. 563, November, 1940).

During the months of March and April, 1941, information was collected on the amount of injury occurring to potatoes shipped from Aroostook points to the Boston wholesale markets and from the wholesale markets to retail stores in Boston. The Farm Credit Administration, the Maine Agricultural Experiment Station, and the Agricultural Marketing Service cooperated in this study. A preliminary report will be released at an early date.

Information was obtained from dealers in the secondary markets around Boston during April, May, and June, 1941. Also during this period attention was directed towards transportation problems in marketing Maine potatoes.

SEED SPACING VARIETY TEST WITH POTATOES. Joseph A. Chucka, Arthur Hawkins, and Joseph L. Harrington. The seed spacing variety test consisted of a comparison of the eight varieties of potatoes which appear to be most commonly grown in Maine. Each of the eight varieties was planted at three different spacings, six-inch, nine-inch, and twelve-inch. They were planted in four-row plots and only the two center rows were used for yield and grading data. Foundation seed stock, practically free of disease, was used in this test and all varieties were uniformly fertilized with 1,250 pounds per acre of an 8-16-20 fertilizer. This test was conducted on two farms, at Aroostook Farm in Presque Isle, and on the Smith Farm in Stillwater.

The average yields of field-run potatoes for the eight varieties ranged from 148 down to 118 barrels per acre at Presque Isle (see Table 13). On the six-inch spacing, the yield range for the eight varieties was 138 to 113 barrels per acre and the varieties ranked in yield in the following order: Warba, Earlaine #2, Sebago, Chippewa, Cobbler, Katahdin, Green Mountain, and Houma. On the nine-inch spacing the yield range was 158 to 117 barrels per acre and the varieties ranked in yield as follows: Earlaine #2, Sebago, Warba, Cobbler, Green Mountain, Katahdin, Chippewa, and Hou-

ma. On the twelve-inch spacing the yield range was 151 to 113 barrels per acre and the varieties ranked in yield as follows: Earlaine #2, Sebago, Chippewa, Green Mountain, Houma, Warba, Katahdin, and Cobbler.

TABLE 13

Comparative Yields of Eight Varieties of Potatoes Aroostook Farm, Presque Isle, Maine—1940

Variety	Yield[1] in barrels per acre	
	Field run	U. S. No. 1
Earlaine #2	148	133
Sebago	136	119
Warba	133	114
Chippewa	126	108
Green Mountain	123	111
Irish Cobbler	121	96
Houma	119	87
Katahdin	118	99

[1] Average yield of three spacings, six-inch, nine-inch, and twelve-inch.

The relatively lower yield secured on the six-inch spacing as compared with the nine- and twelve-inch spacings is not in line with data secured in previous years and was probably due to the shortage of rain during July and August. During 1938 and 1939 both Cobblers and Mountains produced a higher total yield on the six-inch spacing than on either the nine- or twelve-inch spacings.

The average yields of field-run potatoes for the three spacings used at the Smith Farm in Stillwater, Maine, ranged from 140 to 119 barrels per acre as an average of the three spacings (see Table 14). On the six-inch spacing the range in yield for the eight varieties was 149 to 122 barrels per acre and the varieties ranked in yield in the following order: Earlaine #2, Chippewa, Sebago, Cobbler, Katahdin, Warba, Houma, and Green Mountain. On the nine-inch spacing the range in yield was 141 to 121 barrels per acre and the varieties ranked in yield as follows: Sebago, Cobbler, Warba, Chippewa, Houma, Earlaine #2, Katahdin, and Green Mountain. On the twelve-inch spacing the range in yield was 132 to 112 barrels per acre and the varieties ranked in yield as follows: Sebago, Cobbler, Chippewa, Earlaine #2, Warba, Katahdin, Green Mountain, and Houma.

TABLE 14

Comparative Yield of Eight Varieties of Potatoes Smith Farm, Stillwater, Maine—1940

Variety	Yield[1] in barrels per acre	
	Field run	U. S. No. 1
Sebago	140	114
Chippewa	137	101
Irish Cobbler	136	94
Earlaine #2	136	106
Warba	130	94
Katahdin	128	102
Houma	126	88
Green Mountain	119	89

[1] Average yield of three spacings, six-inch, nine-inch, and twelve-inch.

All of the potatoes produced in this test were graded to determine the effect of spacing on tuber size. In general the closer the spacing of plants in the row, the smaller were the tubers produced. Most of the varieties, but particularly Sebago, Earlaine #2, Green Mountain, and Chippewa, produced a considerable number of tubers over ten ounces in weight when the plants were spaced at twelve inches. These large tubers may not be objectionable in table stock but they are objectionable in seed stock.

GREEN MANURE CROPS TEST IN CENTRAL MAINE. Joseph A. Chucka and Joseph L. Harrington. A green manure crop variety trial was conducted on two farms in central Maine during the season of 1940. The crops compared were crimson clover, soybeans, field corn, sudan grass, and millet. Due to the lack of rain during July and August, none of these crops made a satisfactory growth on one farm near Corinna. On the other farm, near Atkinson, there were sufficient local showers so that the growth was fairly satisfactory. On this farm Japanese millet and Western Sweepstakes field corn produced the largest yields of organic matter, each yielding approximately three and three-quarters tons of dry matter per acre. Sudan grass produced about two tons of dry matter per acre while Cayuga soybeans and crimson clover produced only about one and one-half tons of dry matter per acre.

EFFECT OF DATE OF PLOWING UNDER CRIMSON CLOVER PREVIOUS FALL ON YIELD OF POTATOES FOLLOWING YEAR. Arthur Hawkins and Joseph A. Chucka. Many potato growers in Aroostook

County plow under crimson clover early in the fall. It is true that farm labor can be more economically used during the lull which occurs on most farms about two weeks prior to digging operations. In plowing crimson under in late summer, however, a large amount of organic matter that would be produced by deferring the date of plowing is sacrificed. A considerable increase in the yield of dry matter per acre of crimson clover is made between the first week of September and the middle of October during which time usually cool weather prevails and a sufficiency of moisture is available, both factors favorable to the growth of crimson clover. This statement is made on the basis of yield determinations made by taking samples from fields of uniform stands of crimson at 10-day to 2-week intervals during the fall. Over a period of years it has been found that increases in yields of crimson clover between September 10th and October 15th were from 20 per cent to 45 per cent, in terms of dry matter per acre. There is little apparent increase in size of plants during this time of growth, but the percentage of dry weight increases greatly. In 1938 crimson clover samples harvested on two farms on September 9, averaged 17 per cent dry weight; samples from same fields harvested October 10, averaged 28 per cent dry weight.

When the clover is plowed under early in the fall, not only is there less dry matter plowed under but the material being very succulent is more readily decomposed to carbon dioxide and water, and, therefore, considerably less potential humus is added to the soil.

After assuming the cost of preparing the land for seeding, the seed, interest on investment, and taxes on the land, one should, therefore, attempt to produce as much organic matter as possible on that land in the year that it is set aside for this purpose.

Some growers have indicated that it is necessary for them to plow the crimson clover under early in the fall otherwise the organic matter will not decompose fast enough and poor yields of potatoes will result. The cooperation of two growers interested in this problem was obtained to determine what effect deferring the date of plowing under of crimson clover would have on potato yields the following year. Both growers had begun to plow crimson clover under early in September when they were approached regarding this matter. For the purpose of experimentation, they saved a part of their respective fields of crimson clover for later plowing. The

following table shows the effect of deferring plowing on yields of crimson clover and on resulting potato yields.

FARM A

Date of Plowing	Yield of Crimson Clover Dry weight per acre Pounds	1939 Yield of Potatoes Barrels per acre KATAHDINS
August 23, 1938	—	116.8
September 10, 1938	2,091*	119.8
October 12, 1938	2,678	123.4

FARM B

		COBBLERS	CHIPPEWAS
September 9, 1938	3,254	127.3	136.1
October 10, 1938	4,688	129.2	137.3

* Low yields of crimson clover on Farm A are probably due to too early planting—first week in May.

Thirty rows, 60 feet long, were harvested from each section plowed at different dates. The percentage of tubers badly infected with rhizoctonia was determined on the Chippewa variety (Farm B) by Dr. Bonde. There were found 37 per cent and 30 per cent of badly infected tubers on three-barrel samples from sections plowed September 9 and October 12 respectively.

As seen in the above results, under 1939 growing season conditions, there was no decrease in the yield of potatoes resulting from late fall plowing of crimson clover in 1938. On Farm A, soil samples were taken from early and late plowed sections at two-week intervals from June 23 to September 1, both in the ridge and at 8 to 10 inches below the surface level of the field. Results showed a slightly higher amount to twice as much nitrates present in samples from the late plowed section as compared with the early plowed section. This may indicate that decomposition in early fall resulted in loss of nitrates by the time that samples were taken and during which time the potato crop requires it. Not only is more green manure plowed under by deferring plowing until nearly maximum growth has been made, but the material plowed under has a more

lasting beneficial effect in improving the physical and biological conditions of the soil.

FERTILIZER PLACEMENT. Joseph A. Chucka and Arthur Hawkins in cooperation with Bailey E. Brown, Bureau of Plant Industry, United States Department of Agriculture. The 1940 fertilizer placement test consisted of a comparison of the standard fertilizer placement with two high-low placements. The standard placement consisted of placing the fertilizer in two equal bands two inches to the side and slightly below the seed pieces. The high-low placements consisted of placing the fertilizer in two bands two inches to the side of the seed pieces but one band was placed slightly below the level of the seed piece while the other band was placed two inches below the seed piece. The second high-low placement differed from the first in that only one-quarter of the total fertilizer was placed in the upper band and three-quarters in the lower band. These three placements (standard, Hi-Lo 50-50, and Hi-Lo 25-75) were used with both a 1,000 and with a 1,500 pound application of an 8-16-20 fertilizer. Twelve replications of each treatment were used on each of the two farms upon which this test was located. The potato yields produced with these different placements showed no significant differences at either the 1,000 or the 1,500 pound rate of fertilizer application.

POTASH SOURCE AND RATIO TEST. Joseph A. Chucka and Arthur Hawkins in cooperation with Bailey E. Brown, Bureau of Plant Industry, United States Department of Agriculture. This test consisted of a comparison of muriate, sulfate, and nitrate of potash as sources of potash in potato fertilizers in which the nitrogen and phosphoric acid were kept constant at 4 and 8 per cent respectively. The muriate and sulfate of potash were used both as single sources of potash and in combinations while the nitrate of potash was used only as part of the potash used in combinations. The amount of potash was varied from 8 to 16 per cent in the study of the effect of ratios.

On the two farms where this test was conducted during 1940 no significant differences in yield were obtained by varying the amount of potash from 8 to 16 per cent in mixtures containing 4 and 8 per cent of nitrogen and phosphoric acid respectively.

The effect of source of potash secured in 1940 is shown in Table 15. Both the mixtures with sulfate of potash alone and combination sources of potash produced a somewhat higher yield

of potatoes than did the fertilizer containing muriate of potash as the only source of potash.

TABLE 15

Effect of Source of Potash in Fertilizers on Potato Yields—1940

Source of potash	Potato yield in barrels per acre		
	Farm 1	Farm 2	Average
Muriate of potash	117	143	130
Sulfate of potash	132	150	141
⅓ muriate, ⅓ sulfate, and ⅓ nitrate of potash	123	153	138

Samples of potatoes produced with these various treatments were stored in the experimental storage bins at Aroostook Farm and examined for stem-end browning. The tubers produced with the fertilizer mixtures containing muriate of potash developed a somewhat higher percentage of stem-end browning than those which had been produced with fertilizer mixtures that did not contain muriate of potash as a source of potash.

RATE OF PLANT FOOD ABSORPTION BY DIFFERENT VARIETIES OF POTATOES. Arthur Hawkins. It is estimated that upwards of 80 pounds of nitrogen, 160 pounds of phosphoric acid (P_2O_5), 160 pounds of potash (K_2O), 30 pounds of magnesium oxide (MgO), and an undetermined amount of lime and sulphur in the form of mixed fertilizers are applied per acre of Maine's potato crop. Previous to this study the amount of these elements required by a potato crop grown under Aroostook conditions had not been determined. The proportion of one element to another in the fertilizer formula and the total amount of each element applied to a potato crop has not been varied with variety. "The application of nutrients on a rational basis not only requires that the absorbing power of individual species for particular elements be known but that the optimum time for making these elements available to the roots of the growing plant should be considered." [45] Therefore, it appeared advisable to determine the rate of plant food absorption by several varieties of potatoes having different lengths of growing

[45] Lyness, A. S., Plant Physiology 11: 665-668, 1936.

periods. The varieties chosen were: Cobbler, early; Chippewa, intermediate; Green Mountain, late; and Smooth Rural (New York No. 2), very late. These varieties were grown under different rates of fertilizer treatment, namely, no fertilizer, 1,500 pounds, 2,000 pounds, 2,500 pounds, and 3,000 pounds of a 4-8-8 per acre, on Caribou loam having a pH of 5.2 and the following levels of readily available nutrients: P, medium; K_2O, medium; CaO, medium to low; MgO, low.

Twelve (three from each of four plots) uniformly spaced two-stalk plants of representative size of each variety were taken from plots receiving no fertilizer, 2,000-pound, and 3,000-pound applications of a 4-8-8 fertilizer, at ten-day intervals, from the time that the plants were about six inches high to the time of serious loss of foliage, by maturity or early and late blight. Analysis was made of both the plants and tubers of these harvests to determine the total amount of plant food elements taken into the plant to a given date.

In this preliminary report, for the sake of brevity, data will be presented for the most part on harvests of the Green Mountain variety from the plots which received 2,000 pounds of a 4-8-8 fertilizer (containing 80 pounds of nitrogen (N), 160 pounds of phosphoric acid (P_2O_5), 160 pounds of potash (K_2O), 30 pounds

TABLE 16

Amount of Each Major Plant Food Element Absorbed per Acre by Potato Crop During Ten-Day Intervals of Growth (Green Mountain Variety)—1939

Period of growth	Dry weight produced per acre		Plant Food Absorbed per Acre by Plants[1] During Each Period															
			Nitrogen (N)		Phosphoric acid (P_2O_5)		Potash (K_2O)		Magnesium oxide (MgO)		Calcium oxide (CaO)		Sulphur (S)		Total			
Days	lbs.	%	lbs.	%	lbs.	%	lbs.	%	lbs.	%	lbs.	%	lbs.	%	lbs.	%		
0-50	237	3	15.8	11	3.2	12	14.9	7	2.0	7	3.7	7	1.0	8	40.6	9		
50-60	499	7	26.1	18	3.6	13	47.2	23	4.0	13	9.4	17	1.6	13	91.9	19		
60-70	1099	15	36.5	26	4.9	18	64.1	31	7.4	24	15.6	29	3.4	28	131.9	28		
70-80	1866	26	23.0	17	7.4	27	52.6	25	6.9	23	11.4	21	1.7	14	103.0	22		
80-90	1088	15	10.5	7	1.3	5	11.5	6	2.9	10	5.9	11	.5	4	32.6	7		
90-100	1141	16	7.4[2]	5	3.5	13	16.8	8	3.8	12	3.6	6	2.9	24	38.0	6		
100-110	1336	18	22.1[3]	16	3.2	12	0.0		3.5	11	5.0	9	1.1	9	34.9	9		
	7266	100	141.4	100	27.1	100	207.1	100	30.5	100	54.6	100	12.2	100	472.9	100		

[1] Plants include tops, tubers, and most of the roots.
[2] Dry weather.
[3] Plenty of moisture followed dry period.

of magnesium oxide (MgO), and an estimated 220 pounds of calcium oxide (CaO) and 75 pounds of sulphur (S)).

The amounts of the major plant food elements absorbed by the Green Mountain variety at ten-day intervals are given in Table 16. These are calculated on the basis of a 100 per cent stand (plots were hand-planted, seed spaced 12 inches apart).

The data show that under 1939 conditions during the first 50 days after planting the Green Mountain variety absorbed 9 per cent of the total plant food while making 3 per cent of the season's growth. The remaining 97 per cent of the season's growth (7,266 pounds) was divided as follows: between 50 and 60 days after planting, 7 per cent; between 60 and 70 days, 15 per cent; between 70 and 80 days, 26 per cent; between 80 and 90 days, 15 per cent; between 90 and 100 days, 16 per cent; and between 100 and 110 days, 18 per cent.

Of the 91 per cent of the plant food absorbed between the 50th and the 110th day after planting, 69 per cent was absorbed from the 50th to the 80th day.

Less than 16 pounds of nitrogen per acre had been utilized by the plant during the first 50 days after planting, but over 85 pounds was absorbed between the 50th and the 80th day.

Twenty-seven pounds of phosphoric acid (P_2O_5) per acre was taken up by the plants and tubers during the season. The absorption of potash took place very rapidly after the 50th day. Until that time only 15 pounds had been absorbed, but in the next 30 days, 160 pounds was absorbed per acre, and at about twice the nitrogen rate.

Only two pounds per acre of magnesium oxide was found in the plants on the 50th day but over 18 additional pounds was absorbed by the 80th day, and absorption took place until the last harvest, to bring the total amount absorbed to 30 pounds.

The Green Mountain variety absorbed 54 pounds of calcium oxide (CaO) and 12.2 pounds of sulfur per acre.

The amount of each plant food element absorbed per acre by the four varieties of potatoes in 1939 is given in Table 17.

The two later varieties absorbed about 100 pounds more total plant food than the earlier varieties. The later varieties absorbed considerably more nitrogen, potash, calcium oxide, and, as compared with the Cobbler variety, particularly more magnesium oxide. The magnesium oxide content of the tops and roots of the Cobbler

variety was found to be considerably less than the content found in the other varieties, but comparatively little difference was found between varieties in the magnesium content of the tubers. The Cobbler variety absorbed only about 60 per cent as much magnesium oxide as did the later varieties in 1939.

TABLE 17

Amount of Each Major Plant Food Element Absorbed per Acre by Four Varieties of Potatoes

Variety	Pounds of Each Plant Food Element Absorbed by Plants[1]						
	Nitrogen (N)	Phosphoric acid (P_2O_5)	Potash (K_2O)	Magnesium oxide (MgO)	Calcium oxide (CaO)	Sulphur (S)	Total
Cobbler	102.6	21.4	172.1	18.7	44.9	10.6	370.3
Chippewa	103.1	23.3	163.6	26 6	39.3	10.6	366.4
Green Mountain	141.4	27.1	207.1	30.5	54.6	12.2	472.9
Rural	128.5	24.5	211.4	30.5	59.1	10.7	464.7

[1] Plants include tops, tubers, and most of the roots.

The amounts of nitrogen absorbed per acre by the four varieties of potatoes at 10-day intervals of growth are shown in Table 18 and Figure 5.

TABLE 18

Amount of Nitrogen Absorbed per Acre by Four Varieties[1] of Potatoes During Successive Intervals of Growth—1939

Period of growth Days	Nitrogen Absorbed per Acre During Each Period							
	Cobbler		Chippewa		Green Mountain		Rural #2	
	lbs.	%	lbs.	%	lbs.	%	lbs.	%
0-50	23.0	22.0	17.4	17.0	15.8	11.0	10.1	8.0
50-60	36.7	36.0	27.7	27.0	26.1	19 0	29.2	23.0
60-70	28.2	28.0	41.1	40.0	36.5	26.0	27.1	21.0
70-80	14.7	14.0	1.2	1.0	23.0	16.0	40.2	31.0
80-90	0.0	0.0	15.7	15.0	10.5	7.0	2.8	2.0
90-100	0.0	0.0	0.0		7.4[3]	5.0	1.7[3]	1.0
100-110	[2]		[2]		22.1[4]	16.0	17.9[4]	14.0
	102.6	100.0	103.1	100.0	141.4	100.0	128.5	100.0

[1] Arranged in order of maturity—early, intermediate, late, and very late—left to right respectively.
[2] Plants dead.
[3] Dry weather.
[4] Plenty of moisture followed dry period.

The Cobbler variety absorbed 22 per cent of its nitrogen requirements under 1939 conditions by the 50th day as compared with eight per cent for the Rural variety. By the 70th day, Cobblers had absorbed 86 per cent of the nitrogen absorbed during the season as compared to 52 per cent for the Rural and 56 per cent for the Green Mountain varieties.

A detailed discussion of the absorption of each element and the relationship of one element to another found in the plants and tubers of the same variety and comparisons between varieties will of necessity be deferred until all the data can be presented.

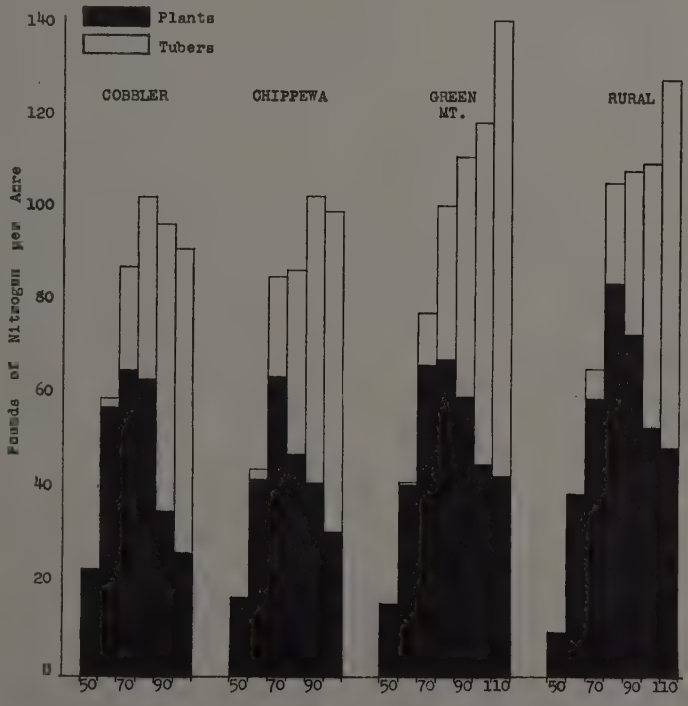

FIG. 5. Amount of nitrogen absorbed per acre by four varieties of potatoes harvested at ten-day intervals (50 to 110 days after planting).

STARTER SOLUTION TEST. Joseph A. Chucka and Arthur Hawkins. A starter solution is a water solution of readily soluble fertilizer materials applied directly on the seed, seed piece, or seedling plant at the time of planting. Starter solutions are used to supply the young plant with a small quantity of readily available plant food near its roots to give it a quick start. Starter solutions supply only a small part of the total nutrient requirements of the plant and therefore are generally used in addition to regular applications of dry fertilizer.

During the 1940 season several concentrations of a starter solution were used on potatoes at planting time on two farms. At Aroostook Farm the use of starter solution had no appreciable effect on yields. However, at Stillwater the potatoes treated with starter solutions came up earlier and produced a much larger yield than those receiving only dry fertilizer. Further work needs to be done on the use of starter solutions on potatoes before arriving at any conclusions relative to their value under Maine conditions.

SPRAYING POTATOES WITH COPPER FUNGICIDES IN COMBINATION WITH ROTENONE FOR THE CONTROL OF DISEASES AND INSECTS. Reiner Bonde and Geddes W. Simpson. The recent epidemics of leafroll and other virus diseases have made it desirable to attempt to control the aphid population in potato fields with an insecticide. It is desirable that the fungicide and insecticide be applied in one field operation in order to reduce the cost to a minimum. An experiment was, therefore, conducted in 1940 on Aroostook Farm for the purpose of determining the compatibility of rotenone and certain commonly used copper fungicides and to determine whether the mixture of fungicide and rotenone would be effective in the control of the foliage diseases.

The plots received seven spray applications of fungicide during the season, using a tractor-power driven machine. Rotenone in the form of ground derris root (4.8 per cent rotenone) was added to the fungicide for six of the applications at the rate of four pounds per acre per application. The rotenone was added to the spray material just prior to spraying the plots.

The yields obtained from the different treatments, the percentage of net necrosis in the crop, and the amount of leafroll and mosaic present in the progeny of the crop, are recorded in Table 19. The addition of rotenone to the copper spray fungicides increased the yield in all instances recorded in this experiment. The increase

derived from applying rotenone was significant statistically in all cases and was from 16 to 31 barrels per acre.

TABLE 19

The Effect on Yield, Net Necrosis, and Leafroll, of Spraying Green Mountain Potatoes with Copper Fungicides and with Combinations of These Fungicides with Rotenone

Fungicide	Formula	Yield per acre		Increase from applying rotenone		Net necrosis[4]		Leafroll[4]		Mosaic[4]	
		Without rotenone	With rotenone			Without rotenone	With rotenone	Without rotenone	With rotenone	Without rotenone	With rotenone
		bbls.	bbls.	bbls.	%	%	%	%	%	%	%
Bordeaux mixture	10-10-100	143±1.68	159±1.16	16	11.2	6.6	6.7	22.8	24.1	14.6	19.5
Basi-cop[1]	5-100	128±2.14	146±1.00	18	14.1	4.4	2.3	15.6	13.3	12.3	13.3
Spray-cop[2]	6-100	125±2.19	156±1.70	31	24.8	4.0	6.5	21.8	24.4	17.1	19.3
Yellow cuprocide[3]	3-100	127±1.82	148±1.47	21	16.5	2.0	3.1	15.5	18.9	15.5	12.7
Unsprayed control	—	123±1.08	—	—	—	1.3	—	10.5	—	12.5	—

[1] Said to contain 52 per cent metallic copper; manufactured by Sherwin-Williams Co., Cleveland, Ohio.

[2] Said to contain 34 per cent metallic copper; manufactured by General Chemical Co., New York, N. Y.

[3] Said to contain 83 per cent metallic copper; manufactured by Röhm and Haas Co., Philadelphia, Pa.

[4] The percentage of net necrosis was determined by cutting and examining the tubers from the different plots after they had been in storage throughout the winter. The percentage of leafroll and mosaic was determined by planting representative samples of the tubers from the different treatments and then examining the resulting plants for the diseases.

Rotenone appeared to increase the yield somewhat less when used with 10-10-100 Bordeaux mixture. It, however, should be observed that plots treated with Bordeaux mixture gave the highest yield rate of all the fungicides. The amount of net necrosis, leafroll, and mosaic, each, was increased nearly a tenth by the application of rotenone. The insecticide prolonged the growth of the plants and accordingly prolonged the period of feeding for the aphids, which in turn probably resulted in more spread of the disease and in more time for the virus to pass down the stems into the tubers.

The spray plots were not rogued. Original infection with leafroll varied between 1.7 per cent and 2.1 per cent of the plants. Mosaic was present in 0.5 per cent of the plants. The rotenone reduced aphid populations in all instances below the populations present in adjacent plots not treated with rotenone.

SPRAYING POTATOES FOR THE CONTROL OF LATE BLIGHT. Reiner Bonde. Late blight was not severe in Aroostook County

during the season of 1940 and the loss from this disease was relatively not very great. Records secured on Aroostook Farm show that rain fell on 23 days during the month of June. The presence of an excessive amount of moisture during the first part of the summer favored the development of late blight and the disease was present in many farm and storage-house dump piles in Aroostook County by June 30. The disease spread from these sources of infection and was found in potato fields in the vicinity of Easton, Fort Fairfield, and Caribou on July 6. The conditions at that time were ideal for an epidemic but because of the dry weather that followed during the rest of the summer, the disease did not spread extensively, and large losses were prevented in most areas.

Late blight, however, was severe on some farms in the area near the Aroostook River between Presque Isle and Caribou. This area is frequented by fogs, which favor the development of the disease.

It should be mentioned that late-blight infection developed on some farms during September, at a time when most growers had stopped spraying potatoes. This late infection resulted in some loss from tuber rot. Tuber rot was reported as being serious in some bins of potatoes in central Maine. The trouble occurred also in both table stock and seed potatoes shipped to our outside markets.

Comparison of Copper-Spray Fungicides. The testing of various copper fungicides for the control of the blight diseases was continued in 1940. The testing of the fungicides was conducted as two separate field experiments. The Green Mountain variety was used for both experiments and the plots received seven applications of fungicide during the season. The first application was made on July 15 and the last on August 30.

The yields secured from these experiments are summarized in Table 20. The plots sprayed with Bordeaux mixture yielded higher in all comparisons. The difference was significant except with respect to tribasic copper sulphate and the basi-cop in Experiment 1. The fact that the plots treated with factory-made copper fungicides failed to give as large yields as plots treated with Bordeaux mixture cannot be attributed to a lack in the ability of such fungicides to control late blight. This disease was well controlled by all of the fungicides. Late blight, although not severe in 1940, caused a considerable amount of injury in the unsprayed plots of Experiment 1 and reduced the yield approximately 84 barrels per acre.

The spread of late blight was quite rapid during the first part of September, after the spraying operations had been completed for the above experiments.

TABLE 20

Yield Comparison of Plots Treated with Different Fungicides Used for Spraying Potatoes

Experiment[1]	Fungicide	Formula	Yield per acre in barrels	Yield reduction in barrels compared with Bordeaux mixture check	Approximate odds in favor of Bordeaux mixture[7]
No. 1	Bordeaux mixture check	10-10-100	167±4.37	—	—
	Tribasic copper sulphate[2]	6-100	164±2.10	3	1 to 1
	Basi-cop[3]	5-100	158±1.59	9	4 to 1
	Basic copper arsenate[4]	5-100	148±3.54	19	45 to 1
	Unsprayed check	—	85±5.22	84	Very high[8]
No. 2	Bordeaux mixture check	10-10-100	143±1.68	—	—
	Basi-cop[3]	5-100	128±2.14	15	1350 to 1
	Spray-cop[5]	6-100	125±2.19	18	19230 to 1
	Yellow cuprocide[6]	3-100	127±1.82	16	19230 to 1
	Unsprayed check	—	123±1.08	20	Very high[8]

[1] The fungicides reported in Experiment 1 were applied with a horse-drawn wheel-traction spray machine. The fungicides reported in Experiment 2 were applied with a tractor-power driven spray machine.
[2] Said to contain 53 per cent metallic copper; manufactured by Tennessee Copper Co., Copperhill, Tenn.
[3] Said to contain 52 per cent metallic copper; manufactured by Sherwin-Williams Co., Cleveland, Ohio.
[4] Said to contain 48 per cent metallic copper; manufactured by Sherwin-Williams Co., Cleveland, Ohio.
[5] Said to contain 34 per cent metallic copper; manufactured by General Chemical Co., New York.
[6] Said to contain 83 per cent metallic copper; manufactured by Röhm and Haas Co., Philadelphia, Pa.
[7] Significance is shown by odds of 22 to 1.
[8] Odds are million or more to 1.

The Effect on Yield of Changing from a Factory-Made Insoluble Copper Spray Fungicide to Bordeaux Mixture Late in the Growing Season. The insoluble copper spray fungicides have the property of not leaving a visible residue when applied to potato foliage. This is a distinct advantage to growers who wish to rogue their fields for the elimination of the mosaic diseases. These fungicides, however, have the disadvantage of being somewhat less effective in controlling certain insects and the blight diseases. In addition, Bordeaux mixture has, as a rule, induced yields, in the experiments, that are greater than those secured from plots sprayed with the insoluble coppers.

The question has arisen whether it would be desirable to spray the fields with the insoluble factory-made fungicides early in the season while the fields are being rogued, and then with Bordeaux mixture late in the season. One series of plots was sprayed with basi-cop and another with spray-cop from the beginning of the season until August 15. After that date, these plots were sprayed with Bordeaux mixture until the close of the season. The plots received four applications of insoluble copper and three applications of Bordeaux mixture. Plots which were sprayed with basi-cop, with spray-cop, and with Bordeaux mixture for the entire season were included as controls.

The yields derived from this experiment are given in Table 21. The plots sprayed for the entire season with Bordeaux mixture yielded more than those plots sprayed with the insoluble coppers the entire season or with the insoluble coppers early in the season and with Bordeaux mixture late in the season. The plots sprayed with Bordeaux mixture yielded from four to seven barrels more per acre than did the other treatments included in the experiment. This increase, however, is not enough to be considered as being statistically significant for these data.

The plots sprayed with the insoluble copper fungicides early in the season and with Bordeaux mixture late in the season, yielded slightly more than did the plots sprayed the entire season with either basi-cop or with spray-cop. This increase of only one and two barrels per acre is too small to be considered as being statistically significant for this experiment.

TABLE 21

The Effect on Yield of Changing from an Insoluble Copper Spray to Bordeaux Mixture Late in the Growing Season

Fungicidal treatment[1]	Yield per acre in barrels
Bordeaux mixture entire season	143±3.59
Spray-cop entire season	136±3.68
Spray-cop to August 15; Bordeaux mixture remainder of season to September 1	138±3.90
Basi-cop entire season	138±3.25
Basi-cop to August 15; Bordeaux mixture remainder of season to September 1	139±2.84
Unsprayed except for control of Colorado beetle	83±5.22

[1] The plots were sprayed seven times during the season beginning July 15 and ending August 30.

Effect of Particle Size on the Fungicidal Value of Insoluble Copper Fungicides. The question has arisen as to whether the ability of the insoluble copper fungicides to control late and early blight can be increased by reducing the particle size of the fungicide. In response to a request for help on this problem, the Sherwin-Williams Company in 1940 supplied two kinds of basi-cop which differed from each other only in their particle size. One type had a relatively large particle size (5-10 microns) and the other had a very fine particle size, namely, two microns or less. These two materials were compared regarding their fungicidal properties on plots of the Green Mountain and Irish Cobbler varieties.

The plots sprayed with fine basi-cop yielded more and kept the foliage green longer than did the coarse basi-cop. This was true with both the Green Mountain and the Irish Cobbler varieties. The difference in yields secured from the use of the two fungicides was not highly significant, however.

Organic Spray Fungicides. Copper fungicides, almost exclusively, have been used for the control of late blight on potatoes. It would be desirable to learn whether other kinds of materials can be used for combating this disease. Several manufacturing companies have in recent years made a search for chemicals which possess fungicidal and bactericidal properties. In 1940 two organic chemicals were tested regarding their ability to control late blight. Both of these materials were found to possess a considerable amount of fungicidal value. They, however, appeared to lack the ability to adhere to the potato foliage and were not able to control the disease late in the season. It is very significant that one of these materials appeared to be a good insecticide and gave good control against infestation by aphids. It is planned to study other chemicals regarding their fungicidal and insecticidal properties.

The Use of Oil as a Carrier for Copper Fungicides. An experiment was conducted in 1940 for the purpose of testing the value of oil as a carrier of certain fungicides.

The fungicides were suspended in a light mineral oil and were atomized onto the plants with a special machine. The oil, as well as the atomizing machine, was supplied by the Shell Oil Company, New York, New York. Two fungicides, namely "yellow cuprocide" manufactured by Röhm and Haas Company, Philadelphia, Pennsylvania, and "spray-cop" manufactured by General Chemical Company, New York, New York, were used in this experiment. About

1.5 pounds of yellow cuprocide in six gallons of oil and four pounds spray-cop in six gallons of oil were applied per acre.

Late blight did not develop in these plots; therefore, it was not possible to determine the effectiveness of the oil fungicides for control of this disease. The experiment did show, however, that it is mechanically possible to use oil as a carrier for the copper fungicides.

INTERNAL MAHOGANY BROWNING OF POTATOES. Merle T. Hilborn. Studies conducted with the new experimental potato storage bins at Aroostook Farm have shown that the so-called mahogany rot of potatoes is caused by low temperature. Chippewas and Katahdins stored at 32° F. through the winter exhibited the

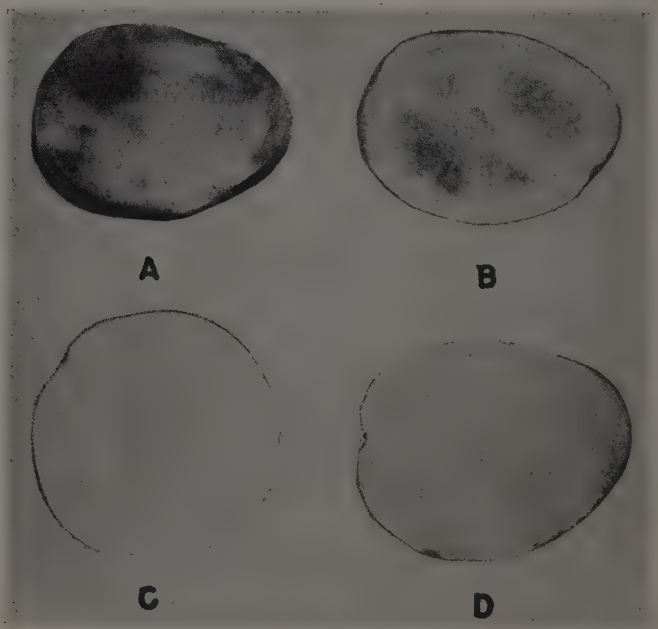

FIG. 6. Tubers cut after several months in experimental storage rooms. A and B, Chippewa at 32° F. and 75 per cent relative humidity. C, Green Mountain kept with A and B. D, Chippewa at 38° F. and 75 per cent relative humidity. The discoloration in A and B was reddish-brown.

reddish-brown discoloration by March. No injury was shown by the same varieties stored at 38° F. or by Green Mountains stored at 32° F. (See Figure 6.) Leafroll aggravated the injury in Chippewas.

EFFECT OF LOW-TEMPERATURE INJURY ON VALUE OF SEED POTATOES IN THE CHIPPEWA AND KATAHDIN VARIETIES. Reiner Bonde. The Experiment Station has received in recent years many specimens of Chippewa and Katahdin potatoes having a reddish internal discoloration which is commonly known as "mahogany browning." This discoloration is attributed to injury caused by the potatoes being stored under too cold conditions. The growers wish to know whether this discoloration affects the value of the potato for seed purposes. An experiment was conducted in 1940 to obtain information regarding this question.

The experiment was conducted with the Chippewa and Katahdin varieties. A seed stock of each of these varieties was divided into three lots with respect to the degree of internal discoloration. One lot contained seed tubers which had no apparent discoloration, the second lot contained tubers with a slight to a medium amount of discoloration, and the third contained seed which was very severely discolored and which contained some internal breakdown and decay. The seed of both varieties was relatively free of the virus diseases.

The data pertaining to this experiment are summarized in Table 22 and indicate that the stand was not significantly reduced by a slight or medium amount of the internal discoloration. This confirms observations made during previous years when tubers having mahogany browning produced normal appearing plants and no apparent reduction in yield. The stand, however, was affected provided the discoloration was severe. Many of the severely affected seed pieces decayed when planted, resulting in blank hills or small weak plants.

The data indicate that the yield may be reduced by planting a seed stock generally affected with internal discoloration of this kind. A slight to medium amount of discoloration in all of the seed pieces in the Chippewa variety reduced the yield 22 barrels per acre in comparison with a part of the same seed stock without the discoloration. This reduction in the yield is significant for this experiment. A slight to medium amount of discoloration in all of the seed tubers

reduced the yield only four barrels per acre in the Katahdin variety. The yield was significantly reduced in both varieties by planting seed from severely affected tubers. The reduction in yield was 54 barrels per acre for the Chippewa variety and 24 barrels for the Katahdin variety.

TABLE 22

Comparison of Stand and Yield when Using Katahdin and Chippewa Seed Stock Having Different Degrees of Internal Discoloration[1]

Variety	Extent of discoloration in seed stock	Percentage of stand	Yield per acre in barrels	Reduction in yield rate in barrels
Chippewa	None apparent	98	133±3.70	—
	Slight to medium	95	111±2.87	22
	Severe, tubers darkened throughout	83	79±2.69	54
Katahdin	None apparent	97	89±2.20	—
	Slight to medium	94	85±3.25	4
	Severe, tubers darkened throughout	89	65±2.91	24

[1] The discoloration is mahogany red and apparently is caused by subjecting the seed stock to too cold storage conditions.

SEED TREATMENT FOR THE CONTROL OF RHIZOCTONIA BY THE ACIDULATED MERCURIC DIP METHOD. Reiner Bonde and Bernie E. Plummer, Jr. *Varietal Differences in Susceptibility to Injury by Acidulated Mercury.* Observations extending over a period of years indicate that the newer potato varieties (Katahdin, Chippewa, and Sebago) are very susceptible to injury resulting from the treating of the seed tubers for the control of Rhizoctonia. An experiment was begun in 1940 for the purpose of obtaining information pertaining to this subject.

Seed potatoes of the Sebago, Green Mountain, and Irish Cobbler varieties were treated by the acidulated-mercuric-chloride short-time-dip method. Both the acetic and the hydrochloric acid mercuric treating solutions were compared. The solutions were made according to the standard formula and contained 1 per cent of the respective acids and 0.2 per cent mercuric chloride. (One quart acid and about 6.66 ounces of bichloride of mercury in 25 gallons of water.)

The tubers were treated in the solutions for five and ten minute

periods, then covered and stored immediately under conditions that usually are favorable for the development of injury to the seed. This was done for the purpose of increasing the amount of injury in order to determine more exactly the relative susceptibility of the varieties. (Growers are advised to dry the potatoes immediately after treating them.)

All of the varieties were injured and pitted by the treatments. The injury, however, was more severe in the Sebago variety and it was apparent that many of the eyes would not grow. The treated tubers were planted in the field, and the percentage of seed pieces that germinated and produced plants was recorded.

Table 23 summarizes the percentage of stand that resulted from treating tubers of the different varieties. The Sebago variety was injured more severely than were the Green Mountain and Irish Cobbler varieties. The treatments did not injure the Green Mountain and Irish Cobbler tubers sufficiently to reduce the stand. The treatments, on the other hand, injured the Sebago tubers to the extent that from 43 to 59 per cent of the seed pieces failed to sprout and produce plants. The solution acidulated with hydrochloric acid reduced the stand somewhat more than did the solution acidulated with acetic acid. The fact that the acetic acid solution caused less injury was apparent also from an examination of the treated tubers. The ten-minute treatment period injured the seed tubers and reduced the stand more than did the five-minute treatment period.

TABLE 23

Effect on Stand and on Yield of Treating the Seed Tubers of Different Varieties with Acidulated Mercuric Solutions[1]

Treating solutions[2]	Length of treatment in minutes	Percentage stand in field			Yield in barrels per acre in Sebagos
		Sebago[3]	Green Mountain[3]	Irish Cobbler[3]	
Hydrochloric acid mercuric	5	52	98	97	63±5.46
Hydrochloric acid mercuric	10	41	97	96	44±2.37
Acetic acid mercuric	5	57	99	95	70±3.77
Acetic acid mercuric	10	46	99	99	58±3.68
Control not treated	—	99	98	98	141±5.17

[1] Potatoes were treated May 20, 1940, during a rainy humid period and were stored wet. This was done to increase the amount of injury caused by the treatments.

[2] The solutions were made to contain one per cent acid and one part in 500 of mercuric chloride.

[3] The treated Sebago tubers were planted in replicated plots for the purpose of securing data on yield. (See Table 24.) Yield data were not secured for the Green Mountain and Irish Cobbler varieties.

The treatments reduced the yield significantly in all cases. The mercuric hydrochloric acid solution reduced the yield more than did the mercuric acetic acid solution. The difference in the reduction in yield caused by the two solutions was not significant statistically when the duration of the treatment was for five-minute periods. (Reduction, seven barrels per acre more by HCl mercuric solution; odds 1.18 to 1.) The difference in the amount of injury caused by the hydrochloric and acetic acid solutions was more apparent when the duration of the treatment was increased to ten-minute periods. (Reduction, 14 barrels more per acre by HCl mercuric solution; odds 31.4 to 1.)

The data secured from the experiment have shown that the Sebago variety is more susceptible to injury by the acidulated mercurial treatment operation than are the Green Mountain and Irish Cobbler varieties. There is some question whether or not it is wise to recommend the practice of treating seed tubers of the Sebago variety by this method under Maine conditions. It sometimes happens that growers severely injure their Green Mountains and Irish Cobblers in treating by the acidulated mercurial method. This excessive injury in most cases has resulted when the tubers were not thoroughly dried immediately after they were treated.

Effect on Yield and on the Control of Rhizoctonia, of Reducing the Acid Concentration of the Acid Mercurial Treating Solution. Previous experiments conducted in Maine have indicated that the amount of acid can be reduced in the acid mercurial treating solution without reducing its ability to control Rhizoctonia. An experiment was conducted in 1940 to gain information pertaining to this subject.

Two mercurial treating solutions were prepared, each containing 0.2 per cent bichloride of mercury. One of these solutions was acidulated by the addition of one per cent by volume of acetic acid and the other solution was acidulated by the addition of one-half per cent by volume of acetic acid. (With one quart and with one pint of acid respectively in 25 gallons of the solution.) Infected Irish Cobbler tubers were treated in the above solutions and planted in the field for the purpose of determining the relative ability of the solutions to control Rhizoctonia. Green Mountain potatoes were treated in the same solutions with the Irish Cobbler tubers and planted for the purpose of securing data on yield. The tubers were treated for five- and ten-minute periods, each five-minute treatment

being alternated with a ten-minute period. Twenty successive treatments were conducted with each of the two treating solutions.

The results obtained from this experiment are recorded in Table 24. The solution containing one per cent acid was not more effective in controlling Rhizoctonia than was the solution containing one-half per cent acid. In fact, seed tubers treated with the solution containing one per cent acid produced more infected plants than did the tubers treated with the less acid solution. The difference, however, is not large enough to be significant. The data support previous information secured that reducing the amount of acid in the acidulated mercurial seed treatment formula to one-half per cent by volume does not reduce the fungicidal effectiveness of the acidulated treating solution.

The slight increase in yield secured with stocks treated with the solution containing one-half per cent acid may be attributed to the fact that this solution injured the seed pieces less than did the solution containing one per cent acid.

TABLE 24

Effect on Yield and the Control of Rhizoctonia, of Reducing the Amount of Acid in the Acidulated Mercurial Treating Solution

Treatment	Length of treatment in minutes	Percentage of plants with rhizoctonia	Yield per acre	
			Bushels	Barrels
Acidulated mercuric chloride ($HgCl_2$ 1-500 and 1 per cent acetic acid)	5	19	405±12.65	147±4.69
Do	10	16	401±12.11	146±4.01[1]
Acidulated mercuric chloride ($HgCl_2$ 1-500 and one-half per cent acetic acid)	5	14	421±10.50	153±3.86
Do	10	12	436±13.26	158±3.88[1]
Control (long time soak) ($HgCl_2$ 1-1,000)	90	8	—	—
Control untreated	—	83	—	—

[1] The difference in yield of 12 barrels per acre in the comparison between the one per cent acid and 10-minute treatment and the one-half per cent and 10-minute treatment is not significant, the ratio being 1.96 and the odds 6.26 to 1. All other comparisons have odds of 1 to 1 or less.

Hydrochloric Acid vs. Acetic Acid for the Preparation of the Acidulated Mercurial Treating Solution. Experiments conducted on Aroostook Farm have indicated the possibility that acetic acid is more desirable than hydrochloric acid for the preparation of the acidulated mercurial treating solution. Acetic acid is less apt to

burn the farmer and his clothing during the process of treating his seed than is hydrochloric acid. Acetic acid also has the advantage of being less injurious to the treated seed potatoes.

An experiment was conducted in 1940 for the purpose of comparing the fungicidal value of mercurial solutions acidulated with acetic and hydrochloric acid respectively. The solutions were prepared according to the standard formula and contained one per cent of the respective acids and 0.2 per cent of mercuric chloride. (One quart of acid and about 6.66 ounces of mercuric bichloride in 25 gallons of water.) Irish Cobbler tubers that were heavily infested with Rhizoctonia were selected for use in the treatment experiment.

It is generally recommended that the tubers be treated from three to five minutes in the solution. The infected tubers in this experiment were treated for five- and ten-minute periods. Each five-minute treatment period was alternated with a ten-minute period. Thirty successive treatments were made with each solution, making 15 treatments for each period of time. A sample of the solution was taken after each fifth treatment for the purpose of determining the amount of acid and mercuric chloride that was present. One hundred seed pieces from each lot of treated tubers were planted in the field, and the plants growing from them were examined for lesions caused by the Rhizoctonia fungus.

The results of this experiment are summarized in Table 25. The hydrochloric acid was reduced 20.77 per cent after being used for 30 treatments and the acetic acid was reduced only 7.13 per cent. It is significant that the mercury content was depleted at about the same rate for both solutions, namely, a loss of 6.83 per cent for the hydrochloric acid solution and a loss of 7.07 per cent for the solution prepared with acetic acid.

There was no significant difference in the ability of the two acidulated solutions to control Rhizoctonia. The average number of infected plants grown from the seed pieces treated with the HCl solution for the 30 treatments was 20.2 per cent and for the plants grown from the seed pieces treated with the acetic acid solution was 20.4 per cent. The average percentage of infected plants for the fifteen five-minute treatments was 19.0 per cent for the HCl solution and 20.5 per cent for those treated with the acetic acid solution. The average percentage of infected plants for the fifteen ten-minute treatments was 21.5 per cent for the HCl solution and 20.3 per cent for those treated with the acetic acid solution.

TABLE 25

Comparison of Treating Solutions Acidulated with Hydrochloric Acid and with Acetic Acid,[1] with Respect to Loss of Acid and Mercuric Chloride and the Control of Rhizoctonia

Treatment number	Length of treatment in minutes	Acidulated with hydrochloric acid			Acidulated with acetic acid		
		HCl[2] %	$HgCl_2$ %	Percentage of plants with rhizoctonia	Acetic acid[2] %	$HgCl_2$ %	Percentage of plants with rhizoctonia
Before treatment		.438	.205		1.26	.198	
1	5	—	—	8	—	—	29
2	10	—	—	16	—	—	24
3	5	—	—	22	—	—	39
4	10	—	—	21	—	—	27
5	5	.401	.203	23	1.26	.196	21
6	10	—	—	33	—	—	33
7	5	—	—	15	—	—	20
8	10	—	—	21	—	—	18
9	5	—	—	14	—	—	31
10	10	.401	.202	16	1.20	.194	14
11	5	—	—	26	—	—	18
12	10	—	—	17	—	—	15
13	5	—	—	31	—	—	14
14	10	—	—	12	—	—	15
15	5	.383	.200	23	1.20	.191	11
16	10	—	—	21	—	—	28
17	5	—	—	18	—	—	12
18	10	—	—	46	—	—	20
19	5	—	—	11	—	—	28
20	10	.365	.198	15	1.17	.191	18
21	5	—	—	26	—	—	21
22	10	—	—	23	—	—	12
23	5	—	—	21	—	—	17
24	10	—	—	18	—	—	28
25	5	.365	.193	19	1.17	.187	19
26	10	—	—	19	—	—	18
27	5	—	—	12	—	—	14
28	10	—	—	14	—	—	17
29	5	—	—	16	—	—	13
30	10	.347	.191	30	1.17	.184	17
Loss of acid after 30 treatments		20.77			7.13		
Loss of $HgCl_2$ after 30 treatments			6.83			7.07	
Average rhizoctonia for 30 treatments				20.2			20.4
Average of 5-minute treatments				19.0			20.5
Average of 10-minute treatments				21.5			20.3

[1] The solutions were made to contain one per cent of the respective acids and 2-500 $HgCl_2$.

[2] pH of HCl solution was 1.1 before experiment was begun and 1.1 after the 30th treatment. pH of acetic acid solution was 3.0 before experiment was begun and 3.1 after the 30th treatment.

This experiment supports the data secured previously that acetic acid is better for the preparation of the acidulated mercurial treating solution than is hydrochloric acid. The acetic acid was depleted from the solution less rapidly than was hydrochloric acid.

The mercury was retained equally by the two solutions and both had about the same fungicidal value.

STUDIES ON THE CONTROL OF THE POTATO RING ROT DISEASE. (BACTERIAL WILT AND SOFT ROT.) Reiner Bonde. The ring rot disease continues to be a major problem of the potato industry of Maine. This disease is being fairly well controlled by the growers of certified seed. The disease, however, is still prevalent in potatoes raised for the table market, or in stocks sold as "selected seed." Data secured by the State and Federal shipping inspection service for the period from January 1 to the end of the 1940-1941 season showed that about 33 per cent of the carload lots of potatoes examined at Maine railroad shipping points contained more or less ring rot. In addition many badly diseased lots were sold to starch factories and were not included in the above mentioned data. Special effort should be made to reduce the amount of ring rot in our potatoes that are being raised for the table stock markets.

Experimental Seed Plots for the Elimination of Ring Rot. The only practical method by which ring rot can be controlled is by the elimination of all diseased seed stocks and by planting seed stocks that are disease free. Seed stocks with even a trace of ring rot should not be planted, if it is intended to use the resulting crop for seed the following year.

Experimental seed plots were grown as sources of seed potatoes free from ring rot. These seed plots were located in communities where ring rot is a serious problem and on farms that have experienced trouble in controlling the disease. An attempt will be made to eliminate the disease on these farms and to build up sources of disease free seed that can be distributed throughout the community. The project will give also practical information regarding the problem of controlling ring rot.

Control by Disinfection of Cut Seed. Experiments were continued in an attempt to find a cheap and effective method of disinfecting cut seed potatoes for reducing the amount of ring rot spread by contamination. None of a number of chemicals used in these studies was more effective than were the acidulated mercurial dip solutions. Treating the seed for five-minute periods in a 1-500 bichloride solution containing one per cent hydrochloric acid or two per cent acetic acid gave excellent control against seed-piece contamination by ring rot.

Control by Disinfection of Containers and Storage Bins. A

study was made to determine the best materials to use for the disinfection of storage bins, containers, and equipment used in producing potatoes. The "Coal Tar Disinfectants" having a phenol coefficient of six appeared to be very efficient in destroying the infection when used at a dilution of 1 quart in 25 gallons of water.

Control by Resistant Varieties. Approximately 200 potato varieties and seedlings were tested regarding their resistance to ring rot. The study indicates that some varieties are highly resistant, having shown no infection for a period of two years after being inoculated by artificial methods.

Leafroll Resistance. Donald Folsom. At Highmoor Farm, 1,083 new seedling varieties were exposed to leafroll infection in the field during the 1939 season. In July, 1940, 81 per cent of these seedlings showed some infection. This rate of disease infection is higher than obtains in Beltsville, Maryland, or at Aroostook Farm in similar tests. The uninfected seedlings, together with others brought from other places in 1940, comprise a total of about 1,000 to be grown at Highmoor Farm in 1941 along with over 2,000 new seedlings from Beltsville. So far, susceptibility to leafroll has eliminated about 2,000 seedlings from 3,000 grown at Highmoor Farm.

Insects in Relation to the Spread of Virus Diseases. Geddes W. Simpson. A study of aphid populations on potatoes in central Maine was continued in 1940. The plots selected for this study were largely foundation seed plots so that roguing records and Florida test plot results can be correlated. Aphid populations on potatoes in central Maine in 1940 were not as great as in Aroostook but peach aphids were, in general, somewhat earlier in relation to plant growth. This provides less time for effective roguing of diseased units in central Maine than is usually available in Aroostook County.

Studies of populations on potatoes planted at different times were continued at Aroostook Farm. The relation of aphid movements to early harvesting dates is important in connection with the work of the foundation seed program. The locations of the foundation seed plots make it possible to accumulate a fund of knowledge that should prove of considerable value in time. The Florida Test provides information on each seed plot and the roguing records from the next year provide information on that part of the crop that was early harvested. The spread in disease content between early

and late harvested portions of a seed plot is a good measure of the late season activities of the aphids.

STEM-END BROWNING AND NET NECROSIS STUDIES. *Experimental Storage Bins.* Joseph A. Chucka, Donald Folsom, Geddes W. Simpson, Reiner Bonde, Arthur Hawkins, and Frank Upton. Twelve experimental storage bins each with a capacity of about 100 barrels were constructed at Aroostook Farm during the summer of 1940. Six of these bins were equipped with cooling apparatus which permitted the maintenance of temperatures between 32° F. and 50° F. The other six bins were equipped with unit heaters to permit the maintenance of temperatures over 50° F. These bins were also equipped with portable calcium chloride driers and sprinkling apparatus for the partial control of humidity.

These experimental storage bins were used for a study of the effect of storage conditions on the development of stem-end browning and net necrosis in potatoes.

Effect of Maturity of Tubers at Harvest Time on the Development of Stem-end Browning and Net Necrosis in Potatoes. Joseph A. Chucka, Arthur Hawkins, and Frank Upton. Ten one-barrel samples of Green Mountain potatoes were harvested at each of the following dates: September 7, September 16, September 27, October 7, and October 16. One barrel sample from each harvest date was placed in each of ten different storage bins and all of the samples were examined for stem-end browning and net necrosis in March. Differences in relative humidity in storage had practically no effect on the development of either stem-end browning or net necrosis in these samples. Temperature differences, however, were very important in determining the amount of both stem-end browning and net necrosis in the tubers. The samples stored at temperatures below 40° F. developed very little stem-end browning and net necrosis while those stored at temperatures over 40° F. developed rather large percentages of both stem-end browning and net necrosis.

At the higher storage temperatures an average of about 25 per cent of the tubers from the first harvest developed stem-end browning. Tubers harvested at the later dates developed progressively less stem-end browning. Those harvested on October 16 showed about eight per cent stem-end browning when stored at temperatures over 40° F.

The effect of maturity of tubers at harvest time was not an important factor in determining the amount of net necrosis in tubers. In general there was somewhat less net necrosis in the tubers from the later harvests.

The Effect of Soil Type and Fertility Level on the Development of Stem-end Browning and Net Necrosis in Potatoes. Arthur Hawkins and Frank Upton. In an attempt to determine the effect of soil conditions on the development of stem-end browning and net necrosis in potatoes, one-barrel samples of potatoes were harvested from 100 different farms scattered throughout the potato producing area of Maine. Soil samples were taken in every location where a tuber sample was obtained. The soil samples were analyzed for acidity, organic matter, and available nutrients. The tuber samples were placed in one of the experimental storage bins at Aroostook Farm until they could be examined for stem-end browning and net necrosis. The tuber samples from 86 of the 100 farms showed some stem-end browning and 77 showed some net necrosis. The soil samples varied widely in acidity, organic matter, and available nutrients but there was no apparent correlation between any of these soil factors and either stem-end browning or net necrosis.

Effect of Rotations and Fertilizer Treatments on the Development of Stem-end Browning and Net Necrosis. Joseph A. Chucka, Arthur Hawkins, and Frank Upton. The permanent plots located at Aroostook Farm include three rotations (one-, two-, and three-year rotations) upon which a variety of fertilizer treatments are used. Furthermore the rotations and treatments have been repeated on the same plots over a period of years. Thus the potatoes grown on these plots are excellent material for the study of the effect of rotations and fertilizer treatments on the development of stem-end browning and net necrosis.

A one-barrel sample of tubers from each of the 55 permanent plots was placed in one of the experimental storage bins and later examined for stem-end browning and net necrosis. The amount of stem-end browning in the samples from individual plots varied from none to 38 per cent. Largest percentages of stem-end browning were found in the samples from the one-year rotation or the plots cropped continuously with potatoes. The samples from the three-year rotation showed the smallest percentages of stem-end browning and those from the two-year rotation developed percent-

ages intermediate between those from the one-year and three-year rotations. Thus the amount of stem-end browning was definitely correlated with the frequency with which potatoes are grown on the same piece of land. This observation would suggest that stem-end browning is caused by a deficiency of some element which is removed by the potatoes and not returned in our fertilization practices or that it is caused by an excess of some substance added in the fertilizer or spray materials used.

Certain treatments within a rotation appear to favor the development of stem-end browning but further research will be needed before the specific cause of stem-end browning will be discovered.

Neither rotations nor fertilizer treatments appeared to be correlated with the amount of net necrosis in the samples from the permanent plots.

CHEMICAL STUDIES ON STEM-END BROWNING OF POTATOES. A. Frank Ross. *Analysis of Tubers.* No significant differences were found in the K, Cl, B, Zn, Mg, Mn, or Co content of the necrotic area of stem-end browning tubers and that of similar areas of normal ones. However, there was a significant difference in copper content. Tubers with stem-end browning ranged from 5.0 to 18.1 p.p.m., average 11.2. Clear-fleshed ones ranged from 11.3 to 31.2 p.p.m., average 20.1. The relationship held, even for the two types selected from the same lot of tubers. The lower figure does not approach copper deficiency. The results suggest, therefore, that a sufficiently high level of copper in the tuber may prevent stem-end browning. Field tests are being conducted this season and further samples will be collected and analyzed.

Chemical and Physical Tests To Distinguish Between Stem-end Browning and Net Necrosis. Many chemical and physical tests were examined for possible use for distinguishing between stem-end browning and net necrosis. No test was found to be more accurate than the method in use, namely, determination of the depth of penetration and general appearance.

Serological Test for Stem-end Browning. Certain substances, called antigens, when injected into the blood stream of animals, cause the production of specific antibodies that react with or neutralize the added substance. If such animals are killed and the blood serum obtained, the reaction will take place in a test tube and is characterized by the formation of a visible precipitate. This

technique was used in the study of stem-end browning. Rabbits were used and eight interperitoneal injections of the juice of diseased tubers were made over a period of four weeks. Ten days after the last injection the rabbits were bled and the serum separated from the red corpuscles. The former was treated with the juice of normal tubers to remove antibodies to normal tuber constituents. When the treated serum was then added to juice from stem-end browning tubers, a visible precipitate formed, whereas none formed when the juice of normal tubers was used. A method was developed for testing individual tubers. During fall and winter months, every tuber tested that showed typical stem-end browning gave a positive test; all but a few normal tubers and those showing net necrosis gave negative results. These results indicate that stem-end browning tubers contain some substance, probably a protein, not present in normal tubers. It is quite possible that this antigenic substance is the cause of the disease. Hence, the test not only serves as a means of distinguishing between stem-end browning and net necrosis but may also serve as a valuable tool in the search for, and the identification of, the cause of the disease. Several viruses, bacteria, and fungi have been tested. All reacted negatively. Considerable work is in progress along this line. During spring and summer months, the test failed to work. This may have been due to the deterioration of the serum or the disintegration of the antigen in the stored tuber.

Attempted Inactivation of Leaf Roll Tuber in the Potato Tuber. Attempts have been made to inactivate leaf roll virus in the tuber so that a seed stock could be cleared of the virus by seed treatment. Heat treatments, applied under conditions that destroy the virus without killing the host, have been successful with some viruses. Treatment of leaf roll tubers with hot water and with ultra-short radio waves has not proved successful. In all cases attempted, the virus survived if the tuber did. Work is still in progress along this line.

Tests for Detection of Leaf Roll Virus in Potato Tubers. If it were possible to segregate diseased tubers from healthy ones by some simple test, the more expensive and time consuming method of Florida testing might be partially displaced. Also small stocks of virus free stock could be planted for propagation.

Chemical, physical, biological, and serological tests have been examined. Of the several tested, only one, consisting of an examination of the tuber under ultra-violet light after a preliminary freezing, has shown any promise. The method is being studied further and the search for other methods continued.

Ethylene Chlorohydrin Treatment of Cobblers. It was found that the reason Cobblers show a poorer response to ethylene chlorohydrin treatment than other varieties is that they absorb the chemical more slowly. They can be made to sprout satisfactorily by increasing the amount of chemical used or by increasing the time of exposure.

STEM-END BROWNING AND NET NECROSIS IN STORAGE. Frank Upton and Donald Folsom. Net necrosis was abundant in stored samples from two Green Mountain fields in which leaf roll had spread, and stem-end browning in stored samples from two Green Mountain fields where it had been found before, providing the storage temperature was held at about 50° F., and providing sufficient storage time had elapsed. There was less of either type of internal discoloration at 38°, 32°, and 60° than at 50°, with the least at 32°. At the optimum temperature, stem-end browning continued to increase until the middle of November, and net necrosis until in April in some series of samples. In November, the warming up of samples previously kept at inhibiting low temperatures induced net necrosis to develop but not stem-end browning; thus the temperature during the first weeks of storage determined the maximum amount of stem-end browning but not the amount of net necrosis that could develop. Relative humidity had no apparent consistent effect on either defect. Storage in barrels made no difference in comparison with storage in boxes. Three series of samples each include about 24 pairs covering all four sources and all dates of examination but with each pair split to compare two temperatures. The results are:

Series	Relative humidity	At lower temperature			At higher temperature		
	Per cent	Temp. °F.	Per cent net necrosis	Per cent stem-end browning	Temp. °F.	Per cent net necrosis	Per cent stem-end browning
A	86 – 89	38	3.3	1.1	38	6.6	1.8
B	79 – 82	39	8.4	2.4	50	17.7	14.1
C	88 – 89	38	5.4	2.1	50	10.6	13.3

The differences in the development of both stem-end browning and net necrosis at the different temperatures were significant (according to the odds by Student's method) for series A and highly significant for series B and C. The percentage of tubers with net necrosis was doubled and the percentage of tubers with stem-end browning was increased still more than two-fold in two series, by the higher temperature.

POTATO STEM-END BROWNING ISOLATIONS AND INOCULATIONS. Donald Folsom. In 1940, fungi and bacteria were isolated from stem-end browning tubers from eight different sources. Of 80 tubers tested, 60 per cent were sterile. Organisms isolated from the rest were inoculated into the stem ends of recently dug Green Mountain tubers in October. These tubers (568 in number) were examined in February, but had less stem-end browning than the 261 check tubers. Reisolation platings were all sterile. It is probable, therefore, that the organisms first isolated were secondary invaders of the diseased stem ends.

GREEN MOUNTAIN TUBER-LINE SEED PLOTS. Donald Folsom. The data from 133 tuber-line Green Mountain potato seed plots grown in Maine during the years 1927 to 1938 have been assembled in manuscript form for publication. Conclusions not hitherto evident are that mosaic came from other fields into 43 of 83 farmers' plots that were originally free of the disease, leafroll into 17 of 39 plots, yellowtop into 3 of 108 plots, and spindle tuber into 1 of 109 plots. Invasion of these seed plots by mosaic and leafroll varied in degree according to the season and other factors. Any relationship to the three factors (1) percentage of disease found and rogued out of these plots, (2) better isolation, and (3) tuber-unit planting was overshadowed by the undesirable effect of the two factors (1) small size of seed plot and (2) later planting and later development of the plants. The frequency of invasion in general was increased by the greater proximity to diseased fields, but the amount of invading disease was not indicated reliably by the State certification rule which disqualifies for a certain amount of proximity. As a rule, leafroll increased more in these plots as they were closer to the southwestern corner of the State, while mosaic increased more as the plots were farther northeast. Tuber-unit planting apparently facilitated effective roguing since more hills of mosaic, leafroll, and yellowtop were

removed from tuber-unit than from bulk planted plots using the same seed stock.

INCREASING SEED STOCKS ON AN ISOLATED FARM. Geddes W. Simpson, Reiner Bonde, and Frank Upton. In 1940 the Experiment Station leased land at McNally Siding for the purpose of increasing seed stocks of a number of different varieties that were in demand.

Seed stocks planted in 1940 were obtained from Aroostook Farm in 1939 and were found to contain considerable disease. Due to a wet spring, planting at McNally was late and some spread of disease was encountered before roguing could be finished.

Seed for 1941 was carefully selected in mid-August, 1940. This seed was found to be nearly free from disease in 1941.

Seed stocks produced in 1940 were, where suitable, offered to foundation seed growers for further increasing. Certain stocks were used as sources of seed for seed plots planted in connection with studies in control of ring rot.

ROGUING SERVICE FOR PRODUCERS OF FOUNDATION SEED POTATOES. Geddes W. Simpson, Reiner Bonde, Wesley F. Porter, and Donald H. Perrin. The foundation seed potato program, started in 1939, is now in its third year of operation. This program is designed to meet a need for better sources of seed for potato growers and to stimulate interest in the manner in which good seed can be propagated year after year. The educational value of the program has had a marked effect on certified growers in that many now have their own seed plots and do their own roguing.

In order to grow foundation seed potatoes there are certain requirements that have to be met. A brief summary of these is as follows: (1) known source of seed to start with; (2) isolation from other potatoes; (3) early planting; (4) planting by tuber unit method; (5) thorough and complete removal of all diseased units; (6) early harvesting; and, (7) testing of sample to insure quality for next year's crop.

In the spring of 1940, 53 growers sent applications to the Experiment Station for the roguing of approximately 237 acres of potatoes. Applications entered varied in size from one-half acre plots to 50 acres. These plots were located in the counties of Aroostook, Penobscot, Piscataquis, Washington, and Waldo.

The season of 1940 was very unfavorable from the standpoint of quality seed production. Planting was later than it would have been in a normal season. This made for late roguing and the plots remained green in the latter part of the growing season when there was a very heavy aphid infestation.

Planting dates ranged from May 11 to June 15. However, in spite of such a variation, roguing was undertaken in the majority of cases by July 1. Roguers were given a training period in the detection and removal of diseased units at Aroostook Farm, Presque Isle, and were then sent on to their assignments. Each man was assigned 15 acres more or less, depending on the distance to be traveled between plots.

Each plot was rogued a single row at a time at least once a week for a period of six weeks.

The highest percentages of the diseased units were removed the first two roguings. This was especially so in the case of leaf-roll. However, mosaic and spindle tuber became more evident as the plants attained more growth.

Purple top showed up as a source of trouble at the time tubers started to set in the Sebago, Katahdin, and Chippewa varieties. In some cases it necessitated the removal of 15 per cent of the plants. Those removed in most cases were in the more advanced stages of the disease. As the roguers were hired on a six weeks' basis, many of the plots did not show this particular disease until roguing was completed for the season. However, those sections of the plot that were to be early harvested were thoroughly rogued at the time that diseased areas were "blocked out."

Seed for another year's plot was taken the week of August 15 on all of those plots that produced tubers having an average weight of a pound to a hill. Early harvested seed was not taken from plots that would not weigh up to this standard by the last week in August. Areas were selected that were as far as possible from diseased units removed earlier. This was done to keep away from centers of infection. In case no such area of sufficient size could be found (as shown by stakes placed by roguer), the procedure was to keep away from such centers of infection by at least 15 plants in each adjoining row, 12 plants in each second row, and 6 plants on each side of the skip where a diseased unit was removed. The amount of seed desired for the next year's plot was

then obtained from plants whose tops were removed by pulling. A period of ten days to two weeks was then allowed for the tubers to harden before digging. Because of its recognized value to seed growers, there was undoubtedly more of this stock made available to Maine growers for planting in 1941 than in any previous year.

Before the remainder of a plot was dug, a test sample was taken. These samples were grown in Florida and checked for disease content. Only those stocks with 1.5 per cent or less of total virus were accepted as of foundation standard. Any stock with over 1.5 per cent was recommended either for use by table stock growers, or to be moved onto the market as table stock. An analysis of the information available on those plots failing to come up to the standard set suggests that, in the majority of cases, the failure was due to laxness on the part of the grower in complying with the regulations and requirements as set up in the foundation program. In many cases weather conditions prevented early planting.

A summary of the varieties and acreages qualifying is given in Table 26.

A considerable amount of tuber index work was carried out in the greenhouse at Orono on several new varieties in an effort to find tubers free from latent mosaics, as well as other, more common, viruses. These are being increased on the Experiment Station seed farm and will eventually be distributed back to the foundation growers.

The use of the greenhouse made it possible also to run checks on early harvest seed from certain of those lots disqualified because of too much disease.

TABLE 26

Acreage, by Varieties, Qualifying as Foundation Seed—1940

Variety	Acreage qualifying	Number of plots qualifying
Bliss Triumph	1.40	1
Chippewa	1.00	1
Cobblers	30.75	10
Green Mountains	30.67	14
Houma	12.00	6
Katahdin	28.50	12
Sebago	25.25	16

FLORIDA TEST PLOT. Geddes W. Simpson, Wesley F. Porter, and Donald H. Perrin. During the winter of 1940-1941, as in the two previous years, seed potato samples were sent to southern Florida to test for the probable disease content of different lots of seed to be grown in Maine in 1941 and entered for certification.

Samples were taken from all plots entered in the 1940 foundation seed program. These plots accounted for 101 of the 311 samples represented. Fields from which the other 210 samples were taken were from tuber-unit seed plots or fields that produced seed that was to be planted for certifying in 1941. The cost to the grower for each of these samples was $15. Thirty experimental lots of potatoes were included in the test.

The manner in which the samples were taken varied. Foundation samples were nearly always taken from the seed plots before digging, by a member of the Experiment Station staff, and consisted of 800 four-ounce tubers from 800 hills in proportional parts of the field. It was necessary that all plants within the plot be dead before the sample was taken. General samples were taken by the growers themselves at time of harvest. These were sometimes taken from barrels in equally spaced parts of the field. Samples of 400 tubers only were taken from fields of one acre or less in area.

It was recommended that four-ounce tubers should be selected in taking the sample. Several of the general samples consisted of tubers weighing six to eight ounces. As a result those samples had 500 to 600 tubers instead of the 800 recommended.

All samples were collected October 1 and were taken to Aroostook Farm, Presque Isle. They were sorted for size, crated, and given a ten-day heat and gas treatment with ethylene chlorohydrin to break the rest period. Irish Cobblers received a double treatment.

Before shipping, numbers were assigned to each sample and they were recorded by their number from this time on.

The Florida planting season ranges from November 1 to December 20. By taking advantage of an early season, planting in 1940 was completed by November 29. Twenty-two acres were needed to plant the test. Each sample was planted in a row by itself. One hundred tubers were split and planted tuber-unit; the rest were planted whole. Each row was blocked off in sections

of 100 tubers, thus giving a basis for a study of the number of tubers actually needed to give accurate readings. From an analysis made, it was found that at least 500 tubers were necessary to secure a reasonably accurate reading.

Because of the variation in which the different varieties reacted to the gas treatment, it was necessary to cut off the ends of each tuber in the slower sprouting varieties, Green Mountain and Irish Cobbler. This was done to make the tubers more permeable to water and to stimulate sprouting.

Emergence counts were taken beginning December 21. First readings were taken on December 24 and continued through to January 22. During this period each sample was read three times. The records were then sent to Orono to be analyzed and published.

The manner in which the different varieties reacted to the ethylene chlorohydrin treatment and reached maturity varied considerably. The order in which readings were obtainable from the standpoint of earliness is as follows: (1) Sebago, (2) Chippewa, (3) Bliss Triumph, (4) Katahdin, (5) Houma, (6) Green Mountain, (7) Earlaine No. 2, (8) Irish Cobbler, (9) Spaulding Rose, and (10) Russet Rurals. In the case of the Russets (1 sample), no readings were available. The seed pieces formed new tubers at each eye.

Weather conditions were very favorable for the reading of diseased plants as well as for sufficient moisture to assure natural plant growth. Leafroll was found in higher percentages than the other viruses and became evident soon after emergence. Other viruses were readily seen. Purple top, which usually shows up in Maine late in July, did not show up in the test plot while readings were being made.

The amount of disease found in the different lots of seed varied considerably. Samples ranged from "no disease evident" up to 68 per cent total virus. The records of all lots showing over 2 per cent total virus were sent to certification officials in Maine at the completion of each day's work. The Chippewa variety showed the highest disease content with only 5 out of 28 samples qualifying. Katahdins were superior to other varieties from a standpoint of low disease count.

A summary of the lots of seed entered by variety and the number of lots recommended is given in Table 27.

TABLE 27

Number of Lots of Seed by Variety Entered in 1940-1941 Florida Test and Number of Lots Recommended for Planting in 1941

	1940 Foundation Program		Certified Seed	
	Number of lots represented	Number of lots recommended	Number of lots represented	Number of lots recommended
Bliss Triumph	1	1	2	1
Chippewa	6	2	22	3
Irish Cobbler	11	10	42	14
Earlaine No. 2	0	0	1	1
Houma	10	8	9	7
Katahdin	15	12	44	33
Green Mountain	32	17	72	35
Russet	0	0	1	No reading
Sebago	26	18	15	8
Spaulding Rose	0	0	2	0
All varieties	101	68	210	102

SMALL FRUIT CROPS

BLUEBERRY INVESTIGATIONS. *Breeding and Selection.* Frederick B. Chandler and Irvin C. Mason. The breeding and selection work has been carried on much as in the past. Two of the crosses made in 1932 produced plants more hardy than the named varieties and with fruit superior to the wild blueberries. Dr. W. H. Camp, of the New York Botanical Gardens, was taken on a trip through all of the principal blueberry areas of Maine. He pointed out that the low-bush blueberry which has formerly been called *V. pennsylvanicum* Lam. and recently has been referred to as *V. angustifolium* Ait. was of two types. These two forms of blueberries do not appear to have the same ecology or habit of growth and fruiting.

Burning. Frederick B. Chandler and Irvin C. Mason. With the assistance of E. C. Meyer, Agricultural Engineer in the College of Agriculture, an oil burner has been constructed which burns a strip of blueberry land about eight feet wide. The cost of burning depends upon the type of land and the climatic conditions. In some sections the cost will be less than burning with hay and will make fall burning as easy as spring burning.

Blueberry By-products. Frederick B. Chandler and Matthew E. Highlands.[46] Blueberry juice was prepared by pressing the

[46] Assistant Bacteriologist, College of Agriculture.

juice from fresh and also from cooked berries. The juice from the cooked berries was of a better color and flavor than that from the fresh berries. The use of pectinol "M" increased the yield of juice from fresh berries.

Weed Control. Frederick B. Chandler and Irvin C. Mason. Geese pastured on blueberry land have greatly reduced the grasses and clover but they must be taken out of the blueberry fields before the berries ripen. Some weeds cannot be controlled by cutting alone nor by the use of a herbicide alone, but can be controlled by applying herbicides to the stubble after the weeds have been cut.

Fruitfulness. Frederick B. Chandler and Irvin C. Mason. The wild bees are gradually disappearing in many of the blueberry fields. Honeybees increase the set of fruit considerably and it has been found that they work most efficiently when located so that it is not necessary for them to fly into the windy parts of the field. They overwinter best when they are well packed with a top entrance. Honeybees will not produce large quantities of honey in the blueberry areas but they will produce enough to pay for the bees and hives if they are given good care.

Mineral Nutrition of Plants. Frederick B. Chandler and Stephen M. Raleigh.[47] Plants grown in fine sand with the continuous flow method do not grow well at first because of the poor aeration. Young plants supplied with nutrients frequently by the flush method grow less than plants supplied only a few times a day. However, older plants grow less when the solution is supplied only a few times a day.

BLUEBERRY INSECTS. Frank H. Lathrop. Experiments on blueberry insect pests were continued during 1940-1941.

Blueberry Fruit Fly (*Rhagoletis pomonella* Walsh). Tests were made of three applications of rotenone dusts in comparison with two applications of calcium arsenate. Each material was applied at the rate of six pounds per acre at each application.

In one test, a plot of ten acres of blueberry land was dusted with a commercial dust containing 0.75 per cent rotenone. Applications were made on July 15, July 22, and August 1. A similar area was dusted with calcium arsenate on July 15 and 22.

At picking time, August 9, representative samples of berries were taken from the plots and examined for fruit fly larvae. The

[47] Assistant Agronomist, College of Agriculture.

berries from the plot treated with calcium arsenate contained an average of two larvae per 20-ounce sample. The berries from the plot treated with 0.75 per cent rotenone dust averaged nine larvae per 20 ounces.

In another test, three adjacent 10-acre plots were dusted. Plot No. 1 was dusted on July 15 and 24 with calcium arsenate. Plot No. 2 was dusted on July 15, July 24, and August 2 with a commercial dust containing 0.5 per cent rotenone. Plot No. 3 was dusted on July 15, July 24, and August 2 with a specially prepared dust containing 2 per cent rotenone derived from ground derris root, and diluted with "Loomkill talc" and "Celite 209" mixed in equal parts. A spreader-sticker, "IN-181-P" (DuPont), was added to the amount of 1 per cent.

On August 9 representative samples of berries were taken from Plots 1, 2, and 3, and were examined for fruit fly larvae. Plot 1, dusted with calcium arsenate, averaged 9.0 larvae per 20 ounces of berries. Plot 2, dusted with a commercial, 0.5 per cent rotenone dust, averaged 48.0 larvae per 20 ounces. Plot 3, dusted with a special, 2 per cent rotenone dust, with spreader-sticker, averaged 7.3 larvae per 20 ounces of berries.

The results of the tests show that three applications of the 2 per cent rotenone dust with sticker-spreader gave slightly better control than two applications of calcium arsenate. Three applications of commercial dust containing 0.75 per cent of rotenone were less effective than two applications of calcium arsenate. Three applications of 0.5 per cent rotenone were distinctly inferior to two applications of calcium arsenate.

The blueberry foliage on the plots dusted with the rotenone insecticides showed distinctly less foliage injury than where calcium arsenate was used.

Blueberry Thrips (*Frankliniella vaccinii* Morgan). In the spring of 1941, two plots of severely thrips-infested blueberry land near Brunswick were sprayed with two ounces of tartar emetic and eight ounces of brown sugar in three gallons of water. Each plot was 21 feet square, and three gallons of the solution was used on each plot for each application. The solution was applied by means of a small wheelbarrow sprayer with a nozzle that produced a fine spray.

The spray was first applied to each plot on May 2 just as the

tips of the earliest blueberry leaves were beginning to separate in the buds. This is the time when the thrips begin to emerge from hibernation. The applications were repeated on May 7, 13, and 20. On May 20 the blueberries in the experimental plots were in full bloom, and thrips injury was in evidence on the plants. The spring of 1941 was exceptionally dry, a condition that should have been favorable for the tartar emetic treatment. In spite of the favorable weather, however, no reduction of thrips injury was apparent on the treated plots, compared with adjacent check plots.

During the fall of 1940 and the spring of 1941, treatments with soil insecticides, begun in the spring of 1939, were continued.

In preparing for the treatments, 15 frames, each six feet square, inside, were made of eight-inch boards. Each frame was placed on an area of blueberry land severely infested with thrips, and the bottom of the frame was sunk into the soil to a depth of about three inches. A space 18 inches wide was marked off outside of each frame, making a plot with a total area of nine square yards, four square yards within the wooden frame, and a border area of five square yards. Twelve of the plots were treated with soil insecticides, and three plots were left untreated. In the spring of 1941, immediately after the spring treatment, and before the thrips started to emerge from the soil, all the frames (including those on the checks as well as the treated plots) were covered with muslin to prevent thrips from coming in from outside to attack the plants within the frames. The 18-inch treated area outside of each frame served as a barrier to prevent the possibility of thrips emerging under the bottom of the wooden frame.

The following soil insecticides were tested:

1.	Dichloroethyl ether	
	Dichloroethyl ether	8 ounces
	Tergitol penetrant 7[48]	15.4 ounces
	Water	24 gallons
2.	Carbon disulphide emulsion	
	Carbon disulphide saturated with Nopcosorb[49]	3 pints
	Water	24 gallons

[48] "Tergitol penetrant 7," a product of Carbide & Carbon Chemicals Corp., 30 E. 42nd St., New York City.

[49] "Nopcosorb," a product of National Oil Products Co., Inc., Harrison, N. J.

3. Ethylene dichloride emulsion	
Ethylene dichloride emulsion[50]	2 gallons, 3 ounces
Water	24 gallons
4. Kerosene emulsion	
Kerosene	24 pints
Soap[51]	¾ pound
Water	24 gallons

Each of the four soil insecticides was applied to one plot in the fall of 1940, to a second plot in the fall of 1940 and again in the spring of 1941, and to a third plot in the spring of 1941. The applications in the fall of 1940 were made on October 25, after the thrips had gone into hibernation in the soil. The applications in the spring of 1941 were made on April 24, before the thrips emerged from hibernation in the soil. Each insecticide was applied at the rate of one gallon per square yard of soil surface. The application was made with a common sprinkling can. Care was taken to distribute the liquid as uniformly as practicable over the surface of the plot.

Careful examinations of the plots made after the thrips injury reached its full intensity, showed that, except for the kerosene emulsion, the treatments had little or no effect in reducing the thrips injury. The kerosene emulsion apparently gave a very satisfactory degree of control, regardless of whether the treatment was applied in the fall or spring, or both fall and spring. None of the treatments appeared to injure the blueberry plants, except for kerosene emulsion applied both fall and spring. Where a single application of kerosene emulsion was made in either fall or spring no injury to the blueberry plants was apparent.

The apparently satisfactory control of blueberry thrips obtained with kerosene emulsion is very gratifying, and it is hoped that the treatment can be developed on a practical basis.

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[50] Ethylene dichloride emulsion, a commercial emulsion, known as "E.D.E.," a product of General Chemical Co., 40 Rector St., New York City.

[51] Proctor & Gamble's "Institution" soap. A hard, dry, white, floating soap.

ANNOUNCEMENTS

Mr. Thomas E. Houghton, by virtue of his retirement from the University Board of Trustees on May 6, 1941, automatically retired from the Station Council as a representative of the Board. Mr. Houghton began his services as a Trustee representative to the Station Council in 1920 and has served continuously in this capacity over a period of 21 years. His attendance at Council meetings has been exceptionally regular and his keen interest in the research program has been helpfully influential for over two decades.

Mr. Frank W. Hussey was appointed by the University Board of Trustees on May 9, 1941, as the Board representative to succeed Mr. Thomas E. Houghton.

Mr. Carl R. Smith, as Commissionr of Agriculture, became a member of the Station Council *ex officio*. Mr. Frank P. Washburn, former Commissioner, retains his membership on the Council as a representative from the University Board of Trustees.

Mr. Fred P. Hagan of Houlton was appointed to the Station Council as a representative of the potato growers of northern Maine.

Mr. Melbourne E. Sanborn of Dover-Foxcroft was appointed to the Station Council as a representative of the Association of Central Maine Potato Growers.

Leave of absence was granted to C. Byron Sibley for one year beginning March 1, 1941, to permit military service under the Selective Service Act.

Leave of absence was granted to John S. Getchell, Assistant in Bacteriology, for one year beginning July 28, 1941. Mr. Getchell was a First Lieutenant in the Reserve Corps and was called to active duty in the present emergency.

Mr. Irvill H. Cheney resigned as Superintendent at Highmoor Farm March 31, 1941. Mr. Cheney had been in this position since 1926. Under Mr. Cheney's administration as Superintendent at Highmoor, the Farm grew tremendously in the esteem of the public and in its service to the agriculture of the State.

Mr. Oayma J. Colby was appointed as Superintendent at Highmoor Farm to fill the vacancy caused by the resignation of Mr. Irvill H. Cheney. Mr. Colby is a graduate of the University of Maine, class of 1929. He assumed his duties at Highmoor on April 10, 1941.

Miss Elizabeth F. Murphy was promoted from Assistant in Biology to Assistant Biologist.

Mr. R. Wilbur Buck, Jr., University of Maine, class of 1941, was appointed to the Maine Canners' Association Fellowship, the appointment to become effective July 1, 1941.

A biochemical laboratory has been provided for the use of the Station in the new wing of Aubert Hall and has been equipped for Dr. A. Frank Ross. Dr. Ross is carrying the chemical research on potato diseases being supported from Potato Tax funds.

A bacteriological laboratory has been provided for the use of the Station in Aubert Hall and is being equipped for studies on potato diseases, particularly bacterial ring rot.

The construction of a two range greenhouse and head house at Aroostook Farm has been approved by the Maine Development Commission with the use of Potato Tax funds. This greenhouse will be ready for occupancy sometime in the fall and will be used in the potato disease research program. This greenhouse will fill a recognized need in the improvement of physical plant for the rapidly developing research program with potato diseases.

PUBLICATIONS

The Station is organized so that the work of investigation is distinct from the work of inspection. The results of investigation are published in the bulletins of the Station and in scientific journals, both foreign and domestic. The bulletins for the year, including this Report of Progress, make up the complete annual report. The results of the work of inspection are printed in publications known as Official Inspections. These are paged independently of the bulletins and may be bound with the annual report as an apppendix thereto. Miscellaneous publications, consisting of newspaper notices of bulletins and newspaper articles which are not paged consecutively and for the most part are not included in the annual report, also are issued during the year.

BULLETINS ISSUED IN 1940-1941

No. 401. The Food Habits and Physical Condition of Children in Selected Communities in Maine. 154 pages.

No. 402. Boron Deficiency Symptoms in Some Plants of the Cabbage Family. 34 pages.
No. 403. Aphids and Their Relation to the Field Transmission of Potato Virus Diseases in Northeastern Maine. 118 pages.
No. 404. Mineral Nutrition of the Genus *Brassica* with Particular Reference to Boron. 94 pages.
No. 405. Report of Progress for Year Ending June 30, 1941. 136 pages.

OFFICIAL INSPECTIONS ISSUED IN 1940-1941

No. 176. Commercial Feeding Stuffs, 1939-1940. 50 pages.
No. 177. Commercial Fertilizers, 1940. 48 pages.
No. 178. Commercial Agricultural Seeds, 1940, and Fungicides and Insecticides, 1940. 32 pages.
No. 179. Foods and Drugs. 131 pages.

MISCELLANEOUS PUBLICATIONS ISSUED IN 1940-1941

No. 562. Manufacture of White Potato Starch in the United States.
No. 563. Marketing Maine Potatoes. A Preliminary Report on Inter-Regional Competition of Maine Potatoes on the Boston Market.
No. 564. A Roguing Service for Producers of Foundation Seed Potatoes.
No. 565. A Preliminary Report of a Survey of the Apple Industry in Maine.

LIST OF AVAILABLE PUBLICATIONS

No. 161. Saddled Prominent.
No. 171. Pine Leaf and Green Winged Chermes.
No. 229. Studies on Oat Breeding. I. Variety Tests, 1910-1913.
No. 266. The Chemical Composition of Green Sprouted Oats. Fish Wastes.
No. 270. Some Eastern Aphids.
No. 272. Inheritance Studies of Color and Horn Characteristics.
No. 273. The Biology of Maine Species of Altica.
No. 276. The Meadow Plant Bug.
No. 278. Soil Test Experiments in 1918.
No. 279. The Variation of the Milk of Ayrshire Cows in Quantity and Fat Content of their Milk.
No. 285. Wheat Investigations I. Pure Lines.
No. 286. The Variation of Milk Secretion with Age in Jersey Cattle.
No. 289. The Correlation Between Milk Yield of One Lactation and that of Succeeding Lactations.
No. 290. The Variation of Butter-Fat Percentage with Age in Jersey Cattle.
No. 291. The Correlation between the Butter-Fat Percentage of One Lactation and Succeeding Lactations in Jersey Cattle.

No. 293. Studies in Milk Secretion. VIII. Influence of Age on Milk and Butter-Fat Yield in Holstein-Friesian Cattle.
No. 296. The Orthoptera of Maine. (Grasshoppers and Allied Insects.)
No. 306. Studies in Milk Secretion. XVII. Relation between Milk Yields and Butter-Fat Percentages of the 7-day and 365-day Tests of Holstein-Friesian Advanced Registry Cattle.
No. 311. The Effect of Age on the Milk Yields and Butter-Fat Percentages of Guernsey Advanced Registry Cattle.
No. 314. Studies on Conformation in Relation to Milk Producing Capacity in Cattle. III. Conformation and Milk Yield in the Light of the Personal Equation of the Dairy Cattle Judge.
No. 318. Interpretation of Dairy Pedigrees.
No. 320. The Influence of Ultra-Violet Light on Nutrition in Poultry.
No. 324. Studies in Milk Secretion. XV. Guernsey Sire's Progeny Performance for Milk Yield, Butter-Fat Percentage, and Butter-Fat.
No. 325. Apple Spraying and Dusting Experiments. 1918 to 1924.
No. 327. Studies in Milk Secretion. XVI. Progeny Performance of Guernsey Sires' Sons.
No. 329. Studies in Milk Secretion. XVII. Transmitting Qualities of Guernsey Sires for Milk Yield, Butter-Fat Percentage and Butter-Fat.
No. 330. Varieties of Ensilage Corn for Maine.
No. 332. Sweet-Corn Breeding Experiments.
No. 339. An Economic Survey of the Apple Industry in Maine.
No. 341. Productivity of Guernsey Cows of American or Island Origin.
No. 344. Bud and Root Selection in the Apple.
No. 347. An Economic Study of 93 Apple Farms in Oxford County, Maine, 1924-1927.
No. 348. Apple Spraying Experiments in 1926-1927.
No. 351. An Economic Study of 239 Blueberry Farms in Washington and Hancock Counties, Maine.
No. 358. Comparison of Apparently Healthy Strains and Tuber Lines of Potatoes.
No. 364. Prices on Farm Products in Maine.
No. 365. The Effect of Handling Methods on Quality of Maine Potatoes.
No. 366. Farm-Property Taxation in Maine.
No. 367. An Economic Study of the Production and Utilization of Milk in Maine.
No. 368. Apple Spraying and Dusting Experiments 1928 to 1932 in Relation to Scab, Yield, and Tree Growth.
No. 370. Isolated Tuber-Unit Seed Plots for the Control of Potato Virus Diseases and Blackleg in Northern Maine.
No. 371. A Study of Factors of Economy in Electrical Cooking of a Typical Day's Meals in Maine.
No. 372. A Survey of the Cooking Practices in Maine Rural and Village Households.

No. 373. An Economic Study of the Collection of Milk and Cream in Maine.
No. 374. Costs and Returns in Operating Milk and Cream Collection Routes in Maine.
No. 375. A Study of the Causes of Nutritional Deficiency Diseases in the Livestock and Inhabitants of Maine with Possible Corrective Methods Secured from the Utilization of Maine Fishery Products and the Production of Superior Foods.
No. 378. A Study of the Organization and Management of Potato Farms in Aroostook County, Maine.
No. 379. A Study of the Organization and Management of Potato Farms in Central Maine.
No. 381. The Bionomics and Control of Wireworms in Maine.
No. 383. Factors Affecting the Cooking Qualities of Potatoes.
No. 385. An Economic Study of Milk Production Costs in Herds of Producer-Distributors in Maine.
No. 386. Evaluation of Certain Factors Affecting the Cost of Using Utensils on Electric Heating Units.
No. 388. A Histological Evaluation of Low Temperature Injury to Apple Trees.
No. 389. Biological Studies of Maine Moths by Light Trap Methods.
No. 390. Costs and Returns in Producing Potatoes in Aroostook County, Maine.
No. 392. Costs and Returns in Producing Potatoes in Central Maine.
No. 393. Food-Plant Catalogue of the Aphids of the World. Including the Phylloxeridae.
No. 394. Performance Analysis of Selected Types of Kerosene Stoves.
No. 395. An Economic Study of Milk Distribution in Maine Markets.
No. 396. Bacterial Wilt and Soft Rot of the Potato in Maine.
No. 397. Report of Progress for Year Ending June 30, 1939.
No. 398. The Organization and Manegement of 95 Dairy and Cash Crop Farms in Androscoggin and Oxford Counties, Maine.
No. 399. Receipts, Utilization, and Prices of Milk and Cream in Maine Milk Control Areas.
No. 400. Report of Progress for Year Ending June 30, 1940.
No. 402. Boron Deficiency Symptoms in Some Plants of the Cabbage Family.
No. 403. Aphids and Their Relation to the Field Transmission of Potato Virus Diseases in Northeastern Maine.
No. 404. Mineral Nutrition of the Genus *Brassica* with Particular Reference to Boron.
No. 405. Report of Progress for Year Ending June 30, 1941.
No. 406. Farm Organization and Costs and Returns in Producing Potatoes on Farms in the St. John River Area of Aroostook County, Maine, 1937.
No. 407. Results of Testing Some Laboratory Methods for Possible Use in the Detection of Virus Diseases in Potato Tubers.
Misc. No. 482. Aphid Galls of the Poplar.

Misc. No. 560. 1939 Vegetable Variety Trials and List of Recommended Varieties.

Misc. No. 561. Marketing Maine Potatoes. I. A Preliminary Report of Consumer Preference for Potatoes in Boston, March 4 to April 6, 1940.

Misc. No. 563. Marketing Maine Potatoes. A Preliminary Report on Interregional Competition of Maine Potatoes on the Boston Market.

Current numbers of Official Inspections, containing results of analyses on foods and drugs, commercial feeding stuffs, commercial fertilizers, commercial agricultural seeds and insecticides and fungicides, are available.

Any of these available publications will be sent free upon request. Also, upon request the name of any resident of Maine will be added to the Station's general mailing list. Persons whose names appear on this list will receive during the year cards giving a summary of bulletins printed and copies will be furnished on request to those interested. The Station is unable to place the name of non-residents of Maine upon its general mailing list. We no longer send our publications regularly to non-residents, except in the case of libraries, exchanges, and agricultural investigators. Teachers, county agents, and others can obtain from the Office of Experiment Stations, Washington, D. C., a monthly list of the publications recently issued by the various experiment stations. In response to a definite request, single copies of the publications of this Station, that are included in the above list, will be sent to any address as long as the supply lasts.

ABSTRACTS OF PAPERS PUBLISHED BY THE STATION IN 1940-1941 BUT NOT INCLUDED IN THE BULLETINS

A complete list of all the bulletins issued by and from the Station in 1940-1941 is given on pages 515 and 516 of this Report. The following pages contain abstracts of the papers published during the year and not included in the Bulletins or Official Inspections.

BOTANICAL AND ECONOMIC DISTRIBUTION OF VACCINIUM L. IN MAINE[1]

The distribution of ten of the species of *Vaccinium* (five blueberry, three cranberry, and two bilberry) was described and illustrated on maps. The distribution of the two low-bush species which return the blueberry growers slightly less than $1,000,000 is shown below in Figure 7.

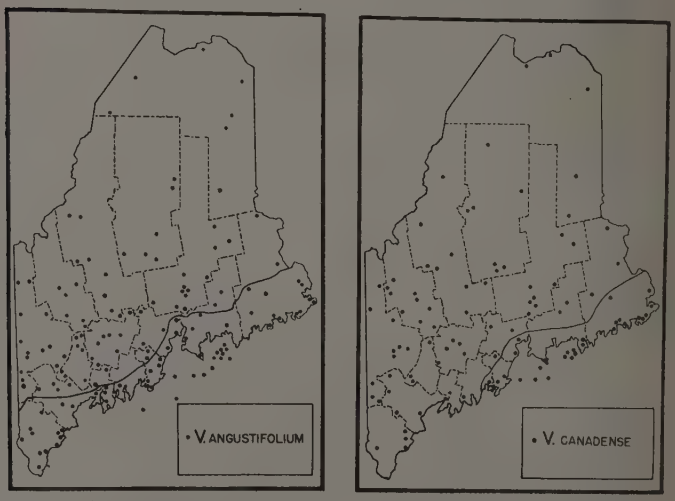

FIG. 7. Distribution of the two species of low-bush blueberry of greatest commercial value in Maine.

RESISTANCE OF CERTAIN POTATO VARIETIES AND SEEDLING PROGENIES TO LATE BLIGHT IN THE TUBERS[2]

Potato seedlings of known parentage were tested for resistance to foliage and tuber infection by the late-blight fungus under field

[1] This is an abstract of a paper by F. B. Chandler and Fay Hyland, having the same title and published in Amer. Soc. Hort. Sci. 38:430-433. 1940.

[2] This is an abstract of a paper by Reiner Bonde, F. J. Stevenson, and C. F. Clark, having the same title and published in Phytopath. 30:733-748. 1940.

and laboratory conditions. A high percentage of them were resistant to tuber and foliage infection when one or both parents were resistant. Foliage resistance, however, was not necessarily accompanied by tuber resistance. Seedlings with resistant tubers and foliage were secured by selfing the susceptible variety Katahdin. Resistance in foliage and tubers appeared to depend on both morphological structure and physiological properties. Tubers of some varieties were susceptible to late-blight decay while immature and resistant when mature. It did not appear that the virulence of the late-blight fungus had been increased by being propagated on certain resistant varieties. Some potato varieties have been grown for ten years with no evidence of having lost their resistance to late-blight infection.

TERMINAL-SHOOT GROWTH OF APPLE VARIETIES AS APPARENTLY STIMULATED BY VIRGINIA CRAB AND HIBERNAL INTERMEDIATE STOCKS[3]

Terminal-shoot growth measurements of twenty apple varieties top-worked on Virginia Crab showed that all varieties made excellent growth. Comparisons were made between the terminal growth of eight of these varieties on clonal or seedling rootstocks and their terminal growth on Virginia Crab intermediate. In all such comparisons, very high odds indicated an invigorating effect of the Virginia Crab intermediate over the rootstock in direct contact. Similar comparisons with Hibernal as the intermediate stock gave significant odds for better growth with Hibernal intermediate in the case of Baldwin and Starking, but the odds were not significant with Delicious. Similar comparisons were made between the growth of five scion varieties on Virginia Crab trunks and their growth on Hibernal trunks. In Baldwin, Cortland, and Delicious, differences in terminal growth were highly significant favoring Virginia Crab. With Starking and Northern Spy the differences were not significant.

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[3] This is an abstract of a paper by M. T. Hilborn and J. H. Waring, having the same title and published in Proc. Amer. Soc. Hort. Sci. (for 1940) 38:316-320. 1941.

HYBRID VIGOR IN SOME TOMATO CROSSES[4]

This paper summarizes the results obtained from the use of F_1 hybrid tomato seeds over a period of seven years. Because of the high yields, especially during the early part of the season, such seed can be of value to growers in short season areas. Among several varieties used in various combinations, Pritchard appeared to be superior to others as parental material. A selection of Red River crossed with Pritchard was considered the best combination studied.

A STUDY OF VITAMIN C NUTRITION IN A GROUP OF SCHOOL CHILDREN. PART II. DIETARY EVALUATION[5]

A study of the vitamin C status of a group of 86 school children in Maine was made during the late fall of 1938 and early spring of 1939, periods when vitamin C containing foods are less abundant than during the summer months.

The following criteria were used to judge vitamin C nutrition:

1. Fall and spring plasma ascorbic acid values as determined by a modification of the Ingalls' technique.[6]
2. The results of urinary tolerance tests on 49 children, 23 of whom were from the group of 86 children.
3. Oral conditions determined by examination in fall and spring.
4. The effect of vitamin C therapy on gum inflammation among 41 children, 26 of whom were from the group of 86 children.
5. Analyses of dietary records kept for one week by 76 children in the autumn and 63 children in the spring of whom 60 and 46 respectively were from the group of 86 children.[7]

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[4] This is an abstract of apaper by Iva M. Burgess, having the same title and published in Proc. Amer. Soc. Hort. Sci. 38:570-572. 1940.

[5] This is an abstract of a paper by Elizabeth Murphy having the same title and published in Jour. Nutr. 21:527-539. 1941.

[6] Ingalls, T. H. Studies on the urinary excretion and blood concentration of ascorbic acid in infantile scurvy. Jour. Pediat. 10:577-591. 1937.

[7] A number of additional records obtained in the spring could not be included because the families had recently received grapefruit from the Federal Surplus Commodities Corporation. The records were, therefore, not considered to represent the child's usual diet.

The children in the study were unselected except for age and sex. The group included 39 boys and 47 girls, ranging in age from 7 to 16 years.

The laboratory tests involving the determination of plasma ascorbic acid and urinary tolerance tests were conducted by Dr. Marian M. Crane of the Children's Bureau, Department of Labor, Washington, D. C. Oral examinations were made by Dr. Phillip W. Woods of the Dental Division, Bureau of Health, Augusta, Maine. It is pertinent to the present report to summarize their results briefly as follows:

Results of the Clinical and Laboratory Studies[8]

1. About 45 per cent of the children in the autumn and nearly 63 per cent in the spring manifested plasma ascorbic acid values of less than 0.40 mg. per 100 ml. Only two children of the group manifested values of 0.80 mg. per 100 ml. or above at both autumn and spring examinations.

2. The urinary tolerance tests demonstrated that the 28 children whose plasma ascorbic acid values were less than 0.40 mg. per cent all excreted less than 10 per cent of a 400 mg. dose of ascorbic acid within six hours after ingestion. In contrast, the four children with values 0.80 mg. per cent or above excreted more than 10 per cent, in three cases 30 per cent or above.

3. Oral examinations showed gum inflammation in slightly more than one-third of the children in the autumn and about one-half of the children in the spring. Of the 24 children with low plasma ascorbic acid values (below 0.40 mg. per cent) both in autumn and spring, only three were free from gum inflammation at both examinations. Of the 17 children with consistently higher plasma values (0.40 mg. per cent or above), 10 were entirely free from inflammation.

4. Of the 41 children included in the therapy test, six children showed extensive, 19 moderate, and 16 slight inflammation. The children were instructed to take orally 200 mg. of crystalline ascorbic acid daily, and were re-examined from 19 to 21 days after therapy

[8] Crane, M. M. and Woods, P. W. A study of vitamin C nutrition in a group of school children. Clinical and laboratory studies. New England Jour. Med. 224:503-509. 1941.

was started. About two-thirds (28) of the 41 children showed improvement in oral condition, 13 being free from inflammation. About one-third (13 children) showed no change in oral condition.

Dietary evaluation. Analyses of 76 fall and 63 spring diet records showed that only one child in seven attained the minimum dietary standard of one good vitamin C food daily.

Storage losses were demonstrated in potatoes, the chief source of vitamin C in the dietaries observed. The ascorbic acid values of raw Green Mountain potatoes decreased from 0.17 mg. per gm. in the fall to 0.11 mg. per gm. in the spring.

Losses during cooking, according to the techniques employed in the region, were as follows: for potatoes, 27 to 55 per cent; for cabbages, 46 to 67 per cent; for rutabagas, 14 to 50 per cent; and for fiddlehead greens, 29 to 56 per cent.

The findings of vitamin C under-nutrition in which 45 and 63 per cent of the children examined showed plasma ascorbic acid values of less than 0.40 mg. per cent, while 32 and 51 per cent of the children showed oral inflammation, are shown to be paralleled by markedly inadequate vitamin C intakes in 58 and 40 per cent of the dietaries examined. The large losses of vitamin C attributed to the effects of storage and poor cooking methods emphasize the dietary relation to the clinical symptoms.

In the light of these analyses, it is suggested that potatoes may not be depended upon to furnish the total amount of necessary vitamin C.

Raw and cooked native cabbage and rutabaga are potential sources of an adequate vitamin C supply.

To conserve vitamin C, cooking methods could be modified to shorten the cooking time and to diminish the amount of cooking water used.

It was demonstrated that varietal differences in vitamin C values among fruits and vegetables are large enough to warrant discrimination in choosing the varieties to be produced and consumed.

The Effect of Plant Spacing on Yield, Ear Size, and Other Characters in Sweet Corn[9]

The effect of different spacings between individual plants in the drill row was studied with both an early and late top cross over a three-year period. The spacings ranged from four to 16 inches.

The earlier maturing, less vegetative top cross required less feeding area for optimum development than did the later maturing one. Soil or climatic conditions, or their interaction, had more influence on yield than did the spacings used in this experiment. Six inches to one foot between plants in drill row, depending somewhat on the variety used, appears to be the most practical range to recommend for most Maine conditions. There was some tendency, within certain limits, for the higher per cent of usable ears to offset the loss in yield in the husk with increased plant spacing. The extreme wide spacing reduced the yield in the husk and also the per cent of usable ears. With all but the greatest spacings as the plant feeding area was increased there was a marked tendency for the plant to produce more ears, heavier and longer ears, and more tillers. Close spacing caused many barren plants. Extreme wide spacing, however, permitted the development of smaller secondary ears and ears on tiller plants which reduced the average ear weight, length, and the per cent of usable ears.

Grass Farming[10]

Among the varied research projects conducted by the Maine Agricultural Experiment Station for the betterment of Maine farming, recent studies in the improvement of grazing lands, popularly known as grass farming, offer possibilities of particular interest to both the farmer and his customer. Although not commonly realized by the average person, grass has always played an important role in the welfare of Maine. Its contribution is variously estimated at from twelve to twenty million dollars annually. But the full importance of grassland farming in our economy is just being recognized. New grassland agriculture brings to

[9] This is an abstract of a paper by R. M. Bailey, having the same title and published in Proc. Amer. Soc. Hort. Sci. 38:546-553. 1940.

[10] This is an article by D. S. Fink appearing in the April, 1941, issue of The Maine Alumnus.

Maine farms a most promising outlook. It opens a new frontier with almost unlimited potentialities for livestock farming.

GRASS FARMING TIMELY

Grass—and by that we mean any of the grasses or legumes used for hay or pasture—has been used for ages as feed for livestock. But only recently has it been possible to preserve grass in its natural green state for winter food. Green feed has long been recognized as an essential in livestock feeding. Today we thoroughly recognize the importance of that green factor, which carries vitamin A, in both animal and human nutrition. Recent experiments show that grass silage is two or three times more potent as a source of vitamin A than is corn silage, and that milk from cows fed grass silage carries much greater vitamin A potency.

Grassland farming with its "all-year" green feed program will contribute much to national health. It is, therefore, imperative that farmers do their part in fortifying feed and foodstuffs with essential health-giving constituents, especially when this can be done economically.

GRASS FARMING ECONOMICAL

Ordinary, "run-out," untreated grass is not the foundation of grassland farming. Livestock require feed rich in digestible protein and carbohydrates, and well fortified with minerals and vitamins. Such feed grows only on well-managed soil.

Soil fertility improvement and maintenance are the foundation of grassland farming. All of our common grassland crops will produce good yields of milk and other livestock products when grown on fertile soil. Experiments at Highmoor Farm show that the yield of native "run-out" grassland in Maine can be raised from 700 pounds of milk per acre to well over 4,000 pounds through surface applications of lime and fertilizer only. This tremendous increase in yield is of immediate importance because it makes grassland improvement economical. Economy in grassland improvement comes largely from greatly reduced supplementary (usually purchased) feed requirements as a result of more abundant and nutritious home-grown feed. Green feed

from fertile grassland will entirely meet the feed requirements of the average good cow throughout most of her lactation period. This includes meeting all mineral requirements, with the exception of common salt, and her needs for all known vitamins. Grass growing on well-managed soil in Maine is fully as nutritious, from the standpoint of all known constituents, as is grass grown elsewhere.

Labor economy is of immediate concern on the farm. Grassland improvement offers the greatest labor-saving device available to livestock farmers. For example, the labor cost to top-dress a pasture with fertilizer is almost negligible, and the cows do the work of harvesting the feed. Obviously, the feed cost of producing milk on excellent pasture is the cost of maintaining soil fertility. This is a departure from previous farmer practice which interpreted the feed cost to produce milk largely in terms of "man-harvested" feed. The Highmoor pasture experiments indicate that an annual application of six tons of farm manure, fortified with superphosphate, per acre, or its approximate equivalent in commercial fertilizer (cost about $12), will maintain an excellent pasture in excellent production. This treatment will regularly produce about 4,000 pounds of milk per acre per year.

Permanent agriculture depends upon a farming system which guarantees permanent soil fertility. We face the problem, because of previous mistakes and neglect, not only of maintaining, but, in many cases, of improving soil fertility. Such a program calls, first of all, for a much greater appreciation of the real fertilizer value of farm manure. All economy in grassland farming is lost if the quick fertility carried in farm manure is dissipated by careless handling. We are at present wasting from one-half to three-fourths of the potential fertilizing value of farm manure.

Soil-fertility improvement further calls for the wise use of purchased lime and fertilizer. Accurate lime and fertilizer recommendations for any crop can be had through the University of Maine soil-testing service.

Maine agriculture has long been handicapped because of the lack of a reasonably permanent hay-type legume. Ladino clover, a new grassland crop to Maine, appears destined to place Maine agriculture on a par with more favorable alfalfa-growing regions.

Ladino clover is a triple-purpose crop, most excellent for

pasture, hay, or grass silage. Actually, in practice, it has been used for all three purposes in a single season. Ladino clover is permanent on adapted soil under good management. We can expect to see and hear much of ladino clover in the very near future.

GRASSLAND FARMING ADAPTED

Maine is primarily a grassland area, and grassland farming is well and easily adapted to our agriculture. Our cool summers with abundant and well-distributed rainfall make for abundant and nutritious grass on properly managed soil.

Much of our good grassland is not well adapted to row crops because it is too rocky. Many of our farms are small, with small and irregularly shaped fields, which make arable farming difficult and costly. All these difficulties are no appreciable handicap in grassland farming. Once land is down to an adapted permanent grassland crop, subsequent annual top-dressings of fertilizer in adequate amounts will maintain the crop and keep the land productive. Many small fields soon become one big field, subdivided only by an electric fence to assure controlled harvesting.

Grassland farming does not involve any great expenditure in equipment or machinery. The application of lime, manure, or fertilizer can be done without machinery, although an efficient manure spreader and a lime and fertilizer distributor should be standard equipment on most farms.

Grassland farming does not call for any change in haying practice. It is believed, however, that considerably less hay will be needed to meet the feed requirements of the herd. Certainly every additional day that the herd is kept on excellent pasture means less barn feed to put up. Feeding experiments to date indicate that excellent grass silage can be relied upon to replace a portion of the ordinary amount of hay fed to cows and young stock. Haying is probably the most uncertain farm job in Maine because it depends on weather. Appreciably lower hay requirements will give more opportunity to make hay when the sun shines.

Grassland farming does require a silo. A simple wooden silo is all that is required on the average farm. An ensilage cutter is, of course, essential, but there is no reason why one cutter should not be able to serve several small farms. Farmers now putting up

corn silage have equipment adaptable to grass silage. A few precautions must be strictly adhered to in making grass silage. A preservative, usually molasses or phosphoric acid, should be added according to directions. The green grass must be tramped continually during filling to avoid air pockets, and the silo should be topped-off to prevent undue spoilage on the surface.

FARM MANAGEMENT SIMPLIFIED

Grassland farming is, above all, a soil building type of agriculture. It is far easier to make future plans on the basis of better soil than on the basis of declining soil fertility. Certainly a more productive home farm helps to bring the boys back home—a most important factor in stabilizing the life of a community.

It was previously noted that grassland farming reduces labor requirements largely through more "cow-harvested" feed. It also distributes labor requirements more evenly over the growing season. It does away with several conflicting and critical labor periods, such as haying and corn cultivation. It lessens the risk of hiring extra labor only to run into inclement weather.

That Maine farmers appreciate the importance of this new grassland agriculture is shown by their wide interest in the pasture improvement campaign being undertaken throughout the State this year.

State and county committees are actively at work in all dairy sections, and pasture meetings and tours this winter and last fall attracted record crowds.

As one measure of what has already taken place, county agents reported that 1,538 men improved 7,190 acres of pasture in 1940, compared with 98 men and 240 acres in 1932.

Certainly the intensified production of grassland crops offers to Maine farmers a new outlook on farm life, and to all consumers, particularly to children, it makes possible an adequate supply of more nutritious milk.

METEOROLOGICAL OBSERVATIONS

The Station is indebted to the Department of Physics of the University for the meteorological summary for Orono for 1940 which appears on the following page.

The instruments used are located on the University campus at Lat. 44° 54′ 2″ N., Long. 68° 40′ 5″ W., Elevation 135 feet. They are the same as those used in preceding years and include: maximum and minimum thermometers, rain gauge, self-recording anemometer, vane, and barometers. The observations at Orono now form an almost unbroken record of seventy-two years.

METEOROLOGICAL SUMMARY FOR 1940
U. of M.: Orono, Maine

1940	January	February	March	April	May	June	July	August	September	October	November	December	Average	Total
Highest temperature	29	56	58	75	92	86	94	95	86	79	72	52	—	—
Lowest temperature	−10	− 6	− 4	20	33	39	46	38	33	23	7	−18	—	—
Mean temperature	14.91	23.36	28.75	40.27	55.93	61.48	69.78	66.80	58.44	45.85	36.13	23.19	43.74	—
Mean temperature in 72 years	16.11	19.24	30.06	40.87	51.23	61.44	69.26	66.02	59.61	49.04	37.44	23.02	43.61	—
Total precipitation in inches	1.23	2.24	2.35	5.17	2.03	2.12	1.42	1.16	5.09	.58	5.10	1.25	—	29.74
Mean total precipitation in 72 years	3.88	3.99	3.47	2.82	3.22	3.46	3.35	3.28	3.54	3.92	3.48	3.55	—	41.96
Number of days with .01 inch precipitation or more	3	4	11	11	11	14	9	4	16	7	13	5	—	108
Snowfall in inches	5	13	12	6	—	—	—	—	—	Trace	11.5	1.25	—	44.25
Mean snowfall in 72 years	20.63	20.65	13.64	5.30	—	—	—	—	—	.66	5.96	14.74	—	81.58
Number of clear days	12	11	7	8	7	3	5	17	7	9	8	8	—	102
Number of partly cloudy days	13	11	11	8	12	13	19	10	10	16	11	18	—	152
Number of cloudy days	6	7	13	14	12	14	7	4	13	6	11	5	—	112
Average wind velocity in miles per hour	4.84	4.31	4.93	4.87	4.44	4.66	4.22	4.38	4.19	4.58	4.31	4.42	4.51	

METEOROLOGICAL SUMMARY
U. of M. Orono, Maine
January–June, 1941

1941	January	February	March	April	May	June
Highest temperature	40	46	57	80	91	97
Lowest temperature	– 8	– 1	10	23	28	41
Mean temperature	15.82	25.46	27.29	47.33	54.97	64.76
Mean temperature in 73 years	16.11	19.32	30.02	40.89	51.28	61.48
Total precipitation in inches	1.84	1.30	4.03	.78	1.62	1.18
Mean total precipitation in 73 years	3.85	3.95	3.48	2.79	3.20	3.43
Number of days with .01 inch precipitation or more	11	5	10	7	8	8
Snowfall in inches	11	2	25	—	—	—
Mean snowfall in 73 years	20.49	20.39	13.78	5.23	—	—
Number of clear days	16	11	12	17	6	11
Number of partly cloudy days	2	7	6	7	11	11
Number of cloudy days	13	10	13	6	14	8
Average wind velocity in miles per hour	4.71	4.68	5.02	4.41	4.16	4.07

METEOROLOGICAL SUMMARY
Aroostook Farm, Presque Isle, Maine
January–June, 1941

1941	January	February	March	April	May	June
Highest temperature	28	40	45	70	81	90
Lowest temperature	–25	–15	– 5	15	22	35
Mean temperature	9.5	19.2	23.0	39.9	51.5	59.7
Mean temperature in 15 years	12.0	13.0	23.7	37.5	50.7	60.2
Total precipitation in inches	3.17	1.34	1.72	1.22	2.65	3.72
Mean total precipitation in 15 years	2.19[1]	1.35[1]	2.30	2.42	3.05	3.84
Number of days with .01 inch precipitation or more	8	6	7	9	10	13
Snowfall in inches	21.0	7.0	9.0	—	—	—
Mean snowfall in 15 years	16.0	12.4	10.1	3.7	0.01	—
Number of clear days	13	7	8	13	10	8
Number of partly cloudy days	6	7	7	8	9	6
Number of cloudy days	12	14	16	9	12	16
Average wind velocity in miles per hour	—	—	—	—	—	—

[1] Fourteen year average.

METEOROLOGICAL SUMMARY FOR 1940
Aroostook Farm, Presque Isle, Maine

1940	January	February	March	April	May	June	July	August	September	October	November	December	Average	Total
Highest temperature	35	37	53	73	83	84	88	88	79	70	55	45	—	—
Lowest temperature	−16	−17	−16	6	30	38	40	35	22	16	—	−21	—	—
Mean temperature	9.6	14.2	22.8	35.0	52.8	59.0	65.8	62.7	56.3	40.1	29.6	15.6	38.6	
Mean temperature in 14 years	12.3	12.6	23.8	37.3	50.7	60.2	65.6	63.9	54.8	44.1	30.3	17.1	39.4	
Total precipitation in inches	1.03	1.02	2.83	3.18	2.07	7.51	3.41	1.67	4.37	1.88	5.38	2.52	—	36.87
Mean total precipitation in 14 years	2.04[1]	1.35[1]	2.34	2.51	3.07	3.85	4.24	3.20	3.71	3.55	2.43[1]	2.20[1]	—	34.49
Number of days with .01 inch precipitation or more	6	6	6	10	12	21	13	6	12	10	15	11	—	128
Snowfall in inches	8.5	10.5	10.5	0.5	—	—	—	—	—	Trace	11.0	12.5	—	53.5
Mean snowfall in 14 years	10.27	9.38	6.83	3.19	0.01	—	—	—	—	1.44	4.43	11.34	—	46.89
Number of clear days	11	21	7	8	10	4	7	18	3	11	6	7	—	113
Number of partly cloudy days	7	2	5	9	7	10	9	4	18	10	6	10	—	97
Number of cloudy days	13	6	19	13	14	16	15	9	9	10	18	14	—	156
Average wind velocity in miles per hour	—	—	—	—	—	—	—	—	—	—	—	—	—	—

[1] Thirteen year average.

RAINFALL RECORDS, HIGHMOOR FARM, 1941
May to October, Inclusive
Readings taken daily between 7:00 and 8:00 a.m.
(Inches of precipitation during preceding 24 hours)

Day	May Rain (inches)	June Rain (inches)	July Rain (inches)	August Rain (inches)	September Rain (inches)	October Rain (inches)
1	—	—	Trace	Trace	.34	.26
2	Trace	—	Trace	.29	Trace	.01
3	.06	.02	.01	—	Trace	—
4	—	—	—	.79	—	.87
5	.01	—	—	—	—	—
6	—	—	—	.05	.19	.24
7	—	—	—	—	.14	Trace
8	—	—	.59	—	Trace	.07
9	.05	Trace	.55	—	Trace	Trace
10	.38	—	.60	.20	—	Trace
11	.01	.01	—	—	.37	.77
12	—	—	—	.24	Trace	—
13	.05	—	.80	.03	Trace	.15
14	.01	.35	.17	Trace	Trace	Trace
15	—	.20	—	—	—	.06
16	—	.02	.01	.48	—	Trace
17	—	.01	Trace	1.39	—	Trace
18	.38	—	.05	Trace	—	—
19	Trace	.10	.02	Trace	—	.10
20	—	Trace	.22	.15	—	Trace
21	—	—	Trace	Trace	—	—
22	—	—	—	—	—	.02
23	—	—	—	—	—	Trace
24	.70	—	—	.02	—	.05
25	.06	Trace	—	Trace	Trace	Trace
26	Trace	—	1.04	.48	—	Trace
27	.36	—	Trace	Trace	—	.02
28	.18	—	.02	—	—	.11
29	.59	.28	.13	—	—	—
30	—	.01	Trace	—	—	—
31	Trace		Trace	Trace		.17

REPORT ON THE FINANCES OF THE STATION

The Station is a department of the University and its accounts are kept in the office of the Treasurer of the University. The books, voucher files, etc., are, however, all distinct from those of the other departments of the University. The classification of accounts is that prescribed by the auditors on the part of the Federal Government, and approved by the State Auditor. All of the accounts may be audited by the State Auditor, and the Hatch Fund, Adams Fund, Purnell Fund, and Bankhead-Jones Fund accounts are also audited by the Office of Experiment Stations acting for the Secretary of Agriculture of the United States in accordance with federal law.

The cost of maintaining the laboratories for the inspection analyses is borne by analysis fees and by the State Department of Agriculture. The income from sales at the experimental farms and the poultry plant is used for the expense of investigations.

At Aroostook Farm there are, in connection with the cooperative work with the Federal Department of Agriculture, certain expenditures for the Department made from sales of crops from Department investigations. These expenditures are carried as distinct and separate accounts, always with credit balances on the Station ledger.